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Stakeholder Attitudes On The Barriers To Innovative Environmental Technologies

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by

The Abt Associates, Inc.

and

The Environmental Law Institute

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EXECUTIVE SUMMARY

This report presents the results of a survey of regulators, users and vendors of environmental technologies. It focuses on these stakeholder groups' perception of barriers to the permitting, use or development of innovative environmental technologies. In this way, it attempts to verify the existence of the barriers identified previously by the reports of the Technology Innovation and Economics (TIE) Committee of the National Advisory Council for Environmental Policy and Technology and other research and publications on technology innovation.

In this report, environmental technologies are defined to include monitoring equipment, treatment and control devices, pollution prevention technologies and process modifications if installed to improve environmental performance. The term innovative environmental technologies refers to systems of pollution prevention or control that have not yet been demonstrated in practice.

The three stakeholder groups were interviewed by telephone about their personal experience in considering innovative environmental technologies in the past five years. Regulators interviewed were chiefs or senior personnel of air, water and waste divisions at state environmental agencies. Users interviewed were managers with responsibility for environmental compliance at facilities holding one or more "major" air, water, or hazardous waste permits. Vendors were leading figures in companies which develop, sell, or recommend environmental technologies. The great majority in each group had over 5 years experience in the environmental field, and over 60% of regulators and vendors had more than 10 years experience. A profile of each group is presented in Part 3, and the results of the interviews in Part 4.

A. Barriers Encountered to Innovative Environmental Technologies

Of those who have considered innovative environmental technologies, most have encountered problems in moving forward with them, led by over 70 percent of vendors who encounter barriers. A salient finding of this research was the strong agreement by all stakeholder groups of the significance of barriers to innovation caused by the regulatory and permitting system, lack of credible information on technology alternatives, lack of financial resources, as well as business practices and related barriers to innovation.

However, while regulators believed that a lack of credible information on technology alternatives is the most significant barrier, vendors and users gave higher priority to the lack of financial resources and barriers created by the regulatory system. The greater need by regulators for data on the performance of innovative technologies confirms the "double barrier" faced by such technologies, as vendors need to convince both users and regulators of the technology's acceptability.

B. Regulatory Barriers to Innovation

1. Barriers. All groups strongly affirm that the following aspects of the regulatory system create barriers to innovation, establishing a broad consensus on the importance of the barriers identified in previous studies. Over two-thirds of each group responded that each listed source of

regulatory barriers creates at least a minor barrier to environmental technology innovation, and for each at least 50% of one or more stakeholder groups regard the barrier as major:

- lack of incentive to exceed minimum compliance;
- uncertainty, excessive length for permit approval;
- permit writers inexperience;
- too little time for testing and implementing.

Both regulators and vendors view the most significant regulatory barrier as the lack of incentive to exceed minimum compliance, whereas users see it as the uncertainty and excessive length for permit approval and permit writers' inexperience. Vendors also view the lack of acceptance of new technologies as a major problem. Regulators tend to place less emphasis on barriers within the permitting system than users or vendors.

Responses among groups also varied dramatically when asked how often companies decide not to pursue a promising innovative technology because of the uncertainty of its complying with environmental regulations or permitting. Forty percent of vendors responded very often, compared to 25 percent of users and only 9 percent of regulators.

2. Sources. When asked whether federal or state laws, regulations or permitting systems caused the barriers, all groups agreed that federal regulations are the most significant barrier, and that federal statutes also create important barriers. Users and vendors also gave high importance to state permitting systems, which regulators did not perceive as a major barrier.

Over 70 percent of each group believe that regulatory systems for air, water or waste are at least somewhat likely to give rise to barriers, and all groups agreed that barriers were most likely to arise from the systems regulating solid or hazardous waste.

3. Solutions. Over 50 percent of users and vendors believe that reducing delays and other changes to the permitting system such as more consistent enforcement and the adoption of overall performance standards would be very helpful in promoting the use of innovative technologies. Regulators consistently placed less emphasis on such changes, placing greatest emphasis instead on government sponsored technology verification and demonstrations.

Respondents were also asked what percentage of current compliance costs they thought could be saved if there were no regulatory or permitting barriers to implementing innovative environmental technologies. A majority in all groups agreed such savings would be substantial, on the order of 25 percent or more. Users and vendors estimated such savings to be only slightly higher than regulators.

C. Business and Other Barriers

1. Barriers. The stakeholder groups were asked to evaluate the importance of financial and internal business barriers to innovation which are unrelated to regulatory barriers. The response was overwhelmingly affirmative, with almost 50 percent of respondents believing most of the barriers listed below to be major ones, and over 85 percent believing them at least minor. To a greater degree

than for the questions concerning regulatory barriers, responses were fairly consistent between the stakeholder groups. The identified barriers were:

- lack of credible data on a technology's cost or performance;
- lack of financing for innovative technologies;
- lack of financial benefits or rewards for using an innovative technology;
- company staff not having enough time to make an assessment of technical options;
- lack of information on the availability of innovative technologies; and
- large investments in technologies in place prevent the selection of new technologies.

2. Financing barriers. Financing is perceived as a major barrier to innovative technologies by all groups. About 50 percent believe it is more difficult to obtain financing for innovative technologies and see the lack of finance as a major barrier to innovative technologies. Less than five percent of each groups think financing may be easier to obtain for innovative technologies.

D. Benefits of using Innovative Environmental Technologies

Roughly 80 percent of all three groups agreed that there are a variety of important benefits in using innovative technologies, including reduced pollution releases, lowered compliance costs and improved production efficiency.

E. Sources for Environmental Technology and Information

When users were asked where the environmental technologies that their firm uses come from, two thirds identified independent vendors, indicating the importance of this community to users regarding environmental compliance issues. The one-half of companies that rely on their own research may also indicate an emphasis on internal process changes as a compliance strategy.

When users and regulators were asked about specific information sources, both groups place highest importance on industry and trade association publications and conferences. Regulators placed next greatest importance on government technical assistance offices and university and extension programs, although only one-quarter of the users rated these as very useful. Users instead place greater reliance on industry: half of users found outside consultants or contracts very useful, and a third regard other companies, their own research, or vendors and suppliers as very useful.

F. Compliance costs

When asked to estimate their facility's annual environmental compliance costs users gave a wide range of answers, presumably according to the size of the operation. Approximately an equal number, or one -fourth of users answered their compliance costs were in the following categories: \$75,000 or less; \$76,000 to 350,000; \$360,000 to \$2 million; and \$2 million or over.

STAKEHOLDER ATTITUDES ON THE BARRIERS TO INNOVATIVE ENVIRONMENTAL TECHNOLOGIES

1. INTRODUCTION

This report presents the results of a survey of regulators, users and vendors of environmental technologies completed in May 1997. It is focused on these stakeholder groups' perceptions of barriers to the permitting, use or development of innovative environmental technologies. In this way, it attempts to verify the existence of the barriers identified previously by the reports of the Technology Innovation and Economics (TIE) Committee of the National Advisory Council for Environmental Policy and Technology and other research and publications on technology innovation.

The survey was administered by telephone to three stakeholder groups: senior permit officials from state environmental regulatory agencies, managers at regulated user facilities, and managers at vendor firms which sell, lease or recommend environmental technologies. There were approximately 460 completed interviews, with more than one hundred from each group. Survey results were then analyzed using statistical tools to determine confidence intervals, described in Appendix A. Survey results are presented below.

In this report, environmental technologies are defined to include monitoring equipment, treatment and control devices, pollution prevention technologies and process modifications if installed to improve environmental performance. The term innovative environmental technologies refers to systems of pollution prevention or control that have not yet been demonstrated in practice.

2. BACKGROUND

A. Why are innovative environmental technologies not being implemented and used?

There is a widespread perception that innovative environmental technologies are not being adequately implemented and used to control pollution, resulting in lower environmental quality to the public and higher costs to industry. Federal activity to investigate the above question has been organized under the National Advisory Council for Environmental Policy and Technology (NACEPT), a public advisory committee advising the Administrator and staff of the U.S. Environmental Protection Agency (EPA). The NACEPT created the Technology Innovation and Economics (TIE) Committee specifically to address the issue.

The TIE Committee convened many multi-stakeholder meetings and issued three reports addressing this question. Their first report issued in 1991 concludes that the disincentives to innovative environmental technologies creates a "market dysfunction symbolized by th[e] lagging rate of

investment in environmental technology."¹ It describes how a number of policies, including government policies, can hinder technology innovation by making it difficult for companies to try something new. It concluded: "Permitting and compliance systems, as they function today, discourage all stakeholder groups from taking the risks necessary to develop innovative technologies", and that "changes to the environmental regulatory system will be needed to create incentives encouraging the environmental technology innovation process".²

The TIE Committee made a series of findings as to why innovative environmental technologies were not being implemented and used.³ They concluded that fundamental changes to the environmental regulatory system would be needed, and offered a series of recommendations. These stressed the need for modifying permitting and enforcement systems, providing incentives and flexibility for innovative technologies, improving testing and demonstration capacity, developing cross-media coordination, identifying and removing regulatory barriers, and developing EPA leadership.

The TIE Committee noted that, while environmental regulations create the market, they can also obstruct and slow innovation: "Regulatory and statutory requirements often limit the potential to introduce flexibility into implementing policies." They further concluded that "the emphasis in the environmental management system on single-medium pollution control strategies is rapidly reaching both technological and cost limits," and that "Existing permitting and compliance authorities at all levels of government lack the flexibility necessary to encourage technology innovation for environmental purposes."⁴

The Committee found that the hurdles facing industry can take many forms. For example, most environmental standards now in place were developed around a particular technology and can have the practical effect of "locking in" that technology's use. The permitting process can also discourage innovation by making the approval process for new technologies longer, more cumbersome, and less certain than for conventional approaches. Even when companies are allowed to use an innovative technology, they may be unwilling to risk non-compliance as they receive no reward for exceeding the minimum regulatory requirements and no protection against failure. Therefore, the same old technologies may be used year after year, freezing out newer and more effective alternatives.

Subsequent to these reports, Congress and EPA established the Environmental Technology Initiative (ETI) in 1994 to help address these problems. ETI was an EPA-led interagency effort that has supported more than 250 projects to advance the development and use of innovative environmental technologies. After initial growth, lack of funding by Congress for the initiative has eliminated the creation of new projects, although previously funded ETI projects are still being finished. But elsewhere,

¹ U.S. Environmental Protection Agency, PERMITTING AND COMPLIANCE POLICY: BARRIERS TO U.S. ENVIRONMENTAL TECHNOLOGY INNOVATION, at 4 (EPA 101/N-91/001, January 1991).

² *Id.* at 7, 15.

³ *Id.* at 26-40.

⁴ USEPA, REMOVING BARRIERS AND PROVIDING INCENTIVE TO FOSTER TECHNOLOGY INNOVATION, ECONOMIC PRODUCTIVITY AND ENVIRONMENTAL PROTECTION, EPA 100-R-93-004, p. iv, viii (April 1993).

EPA has launched innovative programs such as the Common Sense Initiative, which promotes action to address environmental pollution at the sector level, Project XL, a national pilot program to test innovative ways of achieving better and more cost effective environmental compliance, and the Environmental Technology Verification program (ETV).

ETV verifies the performance of innovative technical solutions to problems that threaten human health or the environment. Managed by EPA's Office of Research and Development, ETV was created to substantially accelerate the entrance of new environmental technologies into the domestic and international marketplace. ETV verifies commercial-ready, private sector technologies through twelve pilot programs.

There are also programs at the state level oriented towards addressing the barriers to innovative environmental technologies. A significant effort in this regard has been the formation of the Interstate Technology & Regulatory Cooperation (ITRC) Working Group of 26 states initiated by the Western Governors Association to expedite the use of technology for the characterization and cleanup of contaminated sites. Most participating states agreed to accept each other's test results if agreed upon testing protocols are used, which could make it possible to test a technology in one of the states and have results accepted in the 25 other states.

Other state programs include a memorandum of understanding signed by six states, California, Illinois, New Jersey, Massachusetts, New York and Pennsylvania to establish and implement an information exchange process and interstate technology reciprocity. Another is the New England Interstate Regulatory Cooperation Project, an innovative federal/state partnership designed to promote the acceptance of new environmental technologies in New England and improve the competitiveness of regionally-based companies for marketing environmental technologies.

This survey project intends to further examine stakeholder perceptions of the barriers and problems identified in the above mentioned reports and programs.

B. The lack of venture capital for environmental technologies

Perhaps one of the best ways to examine the health of the environmental technology industry is to review the rate of financing available for new ideas. The TIE Committee of NACEPT concluded in 1990 "that for at least the past decade the rate of investment in environmental technology development and commercialization has lagged."⁵ Since this statement, the level of venture capital financing for environmental innovation has gone from bad to worse: from \$200 million in 1990 to only \$30 million in 1996, in an era of unprecedented funding for technology in general.

⁵ USEPA, PERMITTING AND COMPLIANCE POLICY: BARRIERS TO U.S. ENVIRONMENTAL TECHNOLOGY INNOVATION, at 4 (EPA 101/N-91/001, January 1991).

**Table 1. Venture Capital Available for Investment in Environmental Technologies (\$ millions)
Compared to Industry Size (\$ billions)**

<u>Year</u>	<u>Environmental Industry size</u>	<u>Venture Capital</u>
1988	\$125 billion	\$120 million
1989	137	140
1990	149	200
1991	153	160
1992	159	110
1993	164	75
1994	172	60
1995	179	50
1996	181	30

Source: Environmental Business International (San Diego, CA)

The fall in venture capital financing reflects a similar trend in other financing vehicles for environmental technology development, according to data from Environmental Business International. Between 1993 and 1996, environmental mutual funds have also shrunk, from \$240 million to \$80 million, and government funding has as well. The budget of the Department of Energy's Office of Technology Development has declined from \$400 million to \$290 million, and for the Department of Defense from \$180 to \$150 million.

These data show that financing for environmental technologies is at an all-time low. This crisis severely constrains the development of innovative technologies, especially by independent small technology development companies. The lack of venture capital is especially important, which could be expected to fuel innovation.

The reasons for the lack of financing for environmental technology relate to barriers created by the environmental regulatory system. Interviews with technology financiers reveal two key reasons why they no longer fund environmental technologies while providing considerable funding for technology in general. First, even if a technology works and is commercially acceptable, it faces additional hurdles in the permitting process which may create time delays, lack of acceptance or other problems which prevent commercialization. This "double acceptance" barrier means fewer environmental technologies gain acceptance, and so fewer can become commercialized and profitable.

The second reason concerns market size. Under our federal system, the lack of a national permit approval process means that the environmental market is fractioned into 50 state markets and hundreds of local ones, each one representing a permitting jurisdiction. Approval in one state or jurisdiction is not a guarantee of approval in another, creating a balkanized market which creates a formidable barrier to entry. These two kinds of barriers to innovative environmental technologies help to explain why private capital has virtually left the environmental field, as shown in the table above.

3. SURVEY PROFILES

The following profiles present summary information by stakeholder group, and emphasize the responses in which each group expressed particularly strong views.

A. Regulators

Experience:

- regulators interviewed were heads of air, water and waste permitting divisions at state environmental agencies;
- over 60 % have more than 10 years experience in environmental field and most have considered innovative environmental technologies several times;
- 74 % of regulators responded that their offices are more burdened than they were two years ago.

Barriers:

- 52% have encountered problems moving forward with innovative technologies;
- most view the lack of credible information on technology alternatives as the major barrier to innovative technologies.

Regulatory barriers:

- most view the regulatory system as a minor barrier to technology innovation and see the lack of incentives to exceed minimum compliance as a major regulatory problem; regulators consistently place lesser emphasis on barriers created by the permitting system than do users or vendors;
- only 9 % feel it is very likely that companies decide not to pursue promising innovative technology because of the uncertainty of its complying with environmental regulations or permitting;
- most emphasize government sponsored technology verification and demonstrations to surmount regulatory barriers;

- most perceive federal regulations and federal statutes as the more important sources of barriers, when asked to choose between federal and state laws, regulations, and permitting;
- almost half estimate business could reduce compliance costs by 25 % or more if there were no regulatory barriers to innovative technology.

Other barriers:

- regulators perceive many non-regulatory barriers to be important, and place extremely high value on need for credible data and information about a technology: 75 % of regulators identify the lack of credible data as a major concern, and 62 % perceived the lack of information on the availability of technology as a major barrier;
- over half believe it is harder for innovative technologies to obtain financing, and less than 1 % think it is easier.

Information:

- regulators receive information about alternative technologies from a variety of sources, with the greatest emphasis on government, universities and trade association programs.

B. Users

Experience:

- users interviewed are personnel with responsibility for environmental compliance at regulated facilities;
- over 70 % have more than 5 years experience in the environmental field, and 80 % can name innovative technologies which could potentially be applied to their operations;
- a third of user companies had more than 400 employees at the facility and 14,000 in the company; two thirds believe their company is stronger than it was three years ago.

Barriers:

- 53 % encounter problems moving forward with innovative technologies;
- most view lack of finance, the permit system and the lack of information on technology alternatives as major overall barriers, and de-emphasize business practices and related barriers;

- users feel slightly stronger than other groups that using innovative technologies will lead to both economic and environmental benefits.

Regulatory barriers:

- users perceive many major regulatory barriers, and give greatest emphasis to the uncertainty and excessive length for permit approval, permit writers' inexperience, and lack of time to test and implement new technologies;
- 70 % believe that reducing delays in the permitting system would be "very helpful" in promoting the use of innovative technologies;
- 25 % feel it is very likely that companies decide not to pursue promising innovative technologies because of the uncertainty of complying with environmental regulations or permitting;
- When asked to choose between federal and state laws, regulations and permitting, most perceive state permitting as well as federal regulations and statutes as the more important sources of barriers;
- over half estimate business could reduce compliance costs by 25 % or more if there were no regulatory barriers to innovation.

Other barriers:

- many perceive non-regulatory barriers as important: the lack of staff time to assess technologies, the lack of finance, the lack of economic benefit and the lack of data were considered by most users as major sources of barriers to innovative technologies;
- 42 % believe it is harder to obtain financing for innovative technologies than standard ones, compared to 3 % who find it easier.

Information:

- users receive information about alternative technologies from a variety of sources, with the greatest emphasis on trade association programs, contractors and other industry sources.
- two thirds identify independent vendors as an important source of the environmental technologies that their firm uses, followed by one-half who rely on their own company's research.

C. Vendors

Experience:

- vendors are senior personnel in companies which sell, lease or recommend environmental technologies;
- over 60 % have more than 10 years experience in environmental field and most have considered innovative technologies more than 4 times;
- most vendor companies have fewer than 125 people working at the facility and less than 3,000 in the entire company.

Barriers:

- over 70 % encounter problems moving forward with innovative technologies;
- many perceive the lack of financial resources, the permitting system and business practices all as major overall barriers.
- many feel strongly that using innovative technologies will lead to both economic and environmental benefits.

Regulatory Barriers:

- vendors perceive many regulatory barriers, giving highest priority to the lack of incentives to go beyond minimal compliance, permit writers' inexperience, and the lack of acceptance of innovative technologies within the permitting process;
- 41 % believe firms very often do not pursue promising innovative technology because of the uncertainty of its complying with environmental regulations or permitting;
- When asked to choose between federal and state laws, regulators and permitting, most perceive state permitting as well as federal regulations and statutes as the more important sources of regulatory barriers;
- vendors emphasize more consistent enforcement, reducing delays in permitting and a change from technology-based to overall performance standards as changes that would most benefit innovative technologies;
- over half estimate business could reduce compliance costs by 25 % or more if there were no regulatory barriers to innovation.

Other barriers:

- vendors perceive many non-regulatory barriers as major, and most feel that a lack of economic reward for innovation, a lack of credible data on a technology and a lack of financing are all major sources of barriers to innovative technologies;
- 47 % believe it is harder to obtain financing for innovative technologies than standard ones, and 2 % think it easier.

Research:

- almost half are spending more on research and development than they did three years ago, compared to 17 % spending less; a majority (72 %) conduct R&D primarily through their own staff.

4. SURVEY RESULTS

This part describes the actual results of the survey questions. It begins with background questions, and then addresses barriers to innovation created by the regulatory system, followed by financial and other barriers internal to business firms. Finally, it addresses information sources and other issues.

A. Experience

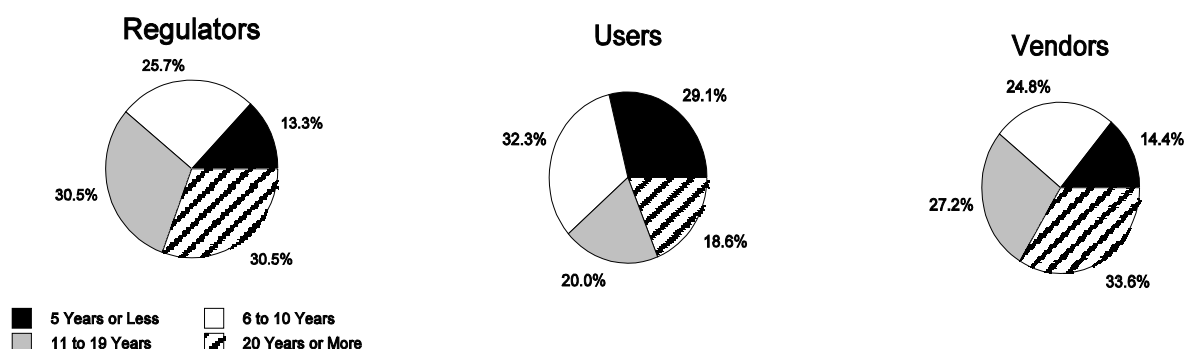
1. *Experience in Environmental Compliance*

Most people interviewed had significant experience in the environmental compliance field. Regulators interviewed were chiefs or senior personnel in the air, water and waste divisions at state environmental agencies. Users interviewed were personnel with responsibility for environmental compliance at facilities holding one or more "major" air, water, or hazardous waste permits. Vendors were senior representatives in companies which develop, sell, or recommend environmental technologies. The great majority in each group had over five years' experience, and over 60 % of regulators and vendors had more than 10 years' experience.

2. *Experience with Innovative Environmental Technologies*

Regulators, users, and vendors were asked about their personal experience in considering innovative environmental technologies in the past five years. All three groups reported a significant amount of exposure to the issue. Over 73 percent of respondents in each group reported having considered innovative environmental technologies at least once, and most had considered innovative environmental technologies twice or more. Environmental technology vendors reported the most frequent consideration of innovative technologies, with the majority (57 %) having considered recommending, selling, or leasing innovative environmental technologies four or more times in the past five years. The respondents having considered innovative environmental technologies at least once went on to complete the survey.

Table 2. How many years have you worked in permitting/environmental compliance/your field?



B. Firm characteristics

Although small, medium and large firms were interviewed in both user and vendor categories, user companies were considerably larger than vendor companies. A third of user companies had more than 400 employees at the facility and 14,000 employed in the company, whereas most vendor companies had fewer than 125 people working at the facility and less than 3,000 in the entire company. User companies surveyed were larger than vendor companies surveyed in part because efforts were made to survey the more regulated, and thus larger, facilities. Also, about two thirds of users and one half of vendors replied their facility has a parent company. Finally, about two thirds of both vendors and users believed that, in terms of competitiveness and financial strength, their company is stronger than it was three years ago. Only about 10 % of respondents felt their company was weaker.

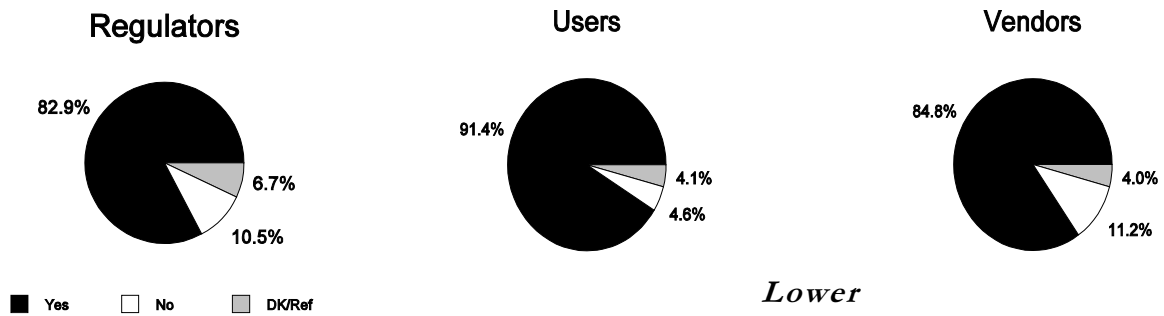
C. Benefits of using innovative environmental technologies

Significant majorities of all three groups agreed that there are a variety of benefits in using innovative technologies. Reduced pollution releases, lowered compliance costs and improved production efficiency are all viewed as important by roughly 80 % of all groups. Fewer permitting problems was viewed as a benefit by slightly fewer respondents.

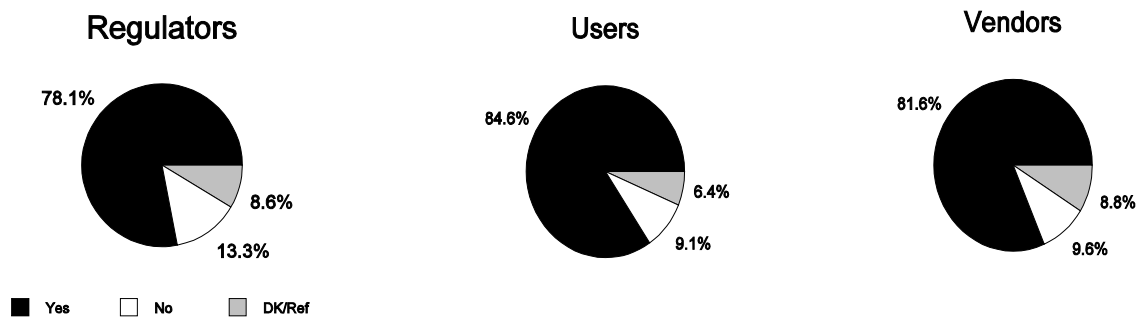
These responses may reflect the actual permitting situation faced by environmental technologies today. Innovative technologies must generally meet or exceed the minimum thresholds established under rate-based end-of-pipe regulatory standards. Business drivers therefore only exist for innovations which both meet and exceed the standards and cost less. Our regulatory system provides few incentives to technologies which may fail to meet an end-of-pipe standard by a slight amount but cost much less, those which exceed the standard but cost more, or those which reduce overall pollution and meet the standard, but may cost more. Indeed, the responses in Table 10 show significant cost savings are available if the barriers to innovative technologies could be reduced. These responses therefore may emphasize current benefits of technology innovation, instead of potential benefits, especially cost reductions, under a regulatory system which focuses more on overall performance than end-of-pipe results.

Table 3. Responses indicating significant benefits of using innovative environmental technologies

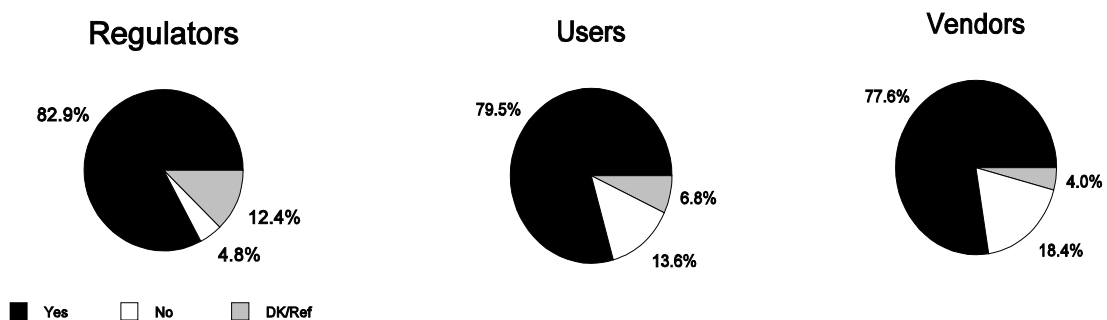
Reduced pollution releases:



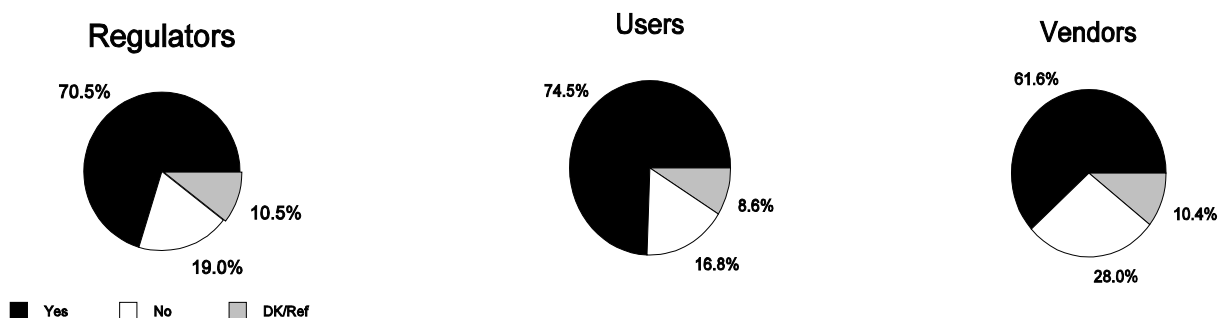
Lower compliance costs:



Improved production efficiency:



Fewer problems complying with environmental permits:



D. Frequency and Types of Barriers Encountered by Innovative Environmental Technologies

Of those who have considered innovative environmental technologies, most have encountered problems in moving forward with them. Vendors encountered the most problems, with over 70 % encountering barriers. This, coupled with the results showing that vendors more often consider innovative technologies, may imply that many innovative technologies never make it past the vendors to the users. Vendors may consider the potential barriers a technology may face and screen out technology innovations.

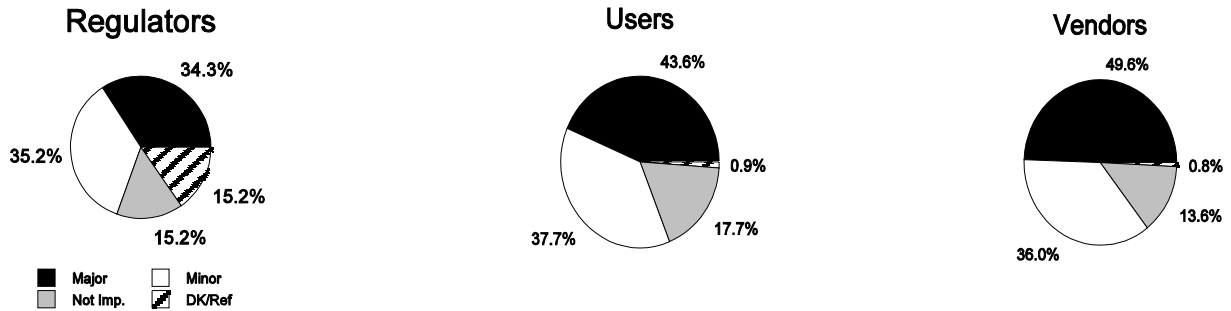
When asked about the importance of different types of barriers, there was general agreement that all those listed (regulatory or permitting system, lack of credible information on technology alternatives, lack of financial resources, and business practices and related barriers to innovation) have some importance. However, there were differences between the groups as to which barrier they regard as the most important.

While regulators believed that a lack of credible information on technology alternatives is the most significant barrier, vendors and users gave higher priority to the lack of financial resources and barriers created by the regulatory system. The greater need by regulators for data on the performance of innovative technologies confirms the "double acceptance barrier" faced by environmental technologies. They must not only surmount the normal business and economic barriers to approval, but, unlike other technologies, also get regulatory approval. Since regulators appear to have greater needs for data than business representatives, it appears that some innovative technologies which would be approved by business may not be by regulators.

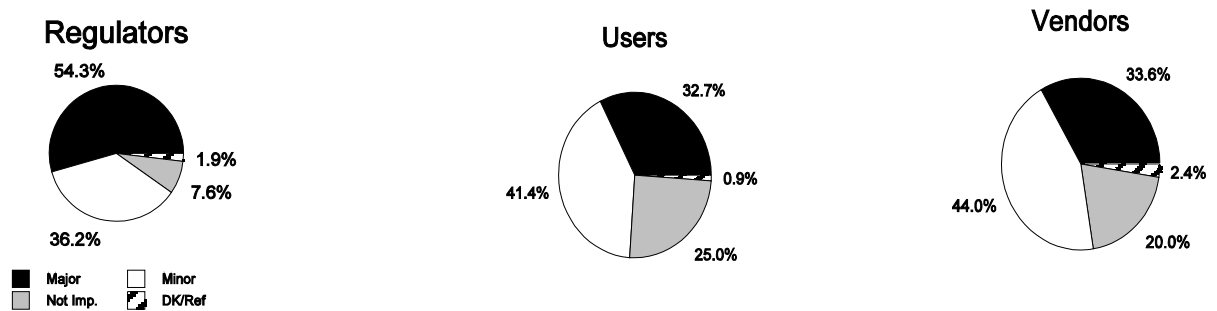
Perhaps predictably, each group viewed barriers within their own sphere as causing the fewest problems. Few users view their own business practices as a major barrier, nor did many regulators view the regulatory process as a major barrier, though both groups did view these problems as minor barriers. Vendors also placed least importance on the need for credible information on technology alternatives, as perhaps they feel that they adequately develop and prove innovative technology alternatives.

Table 4. Responses identifying major sources of barriers

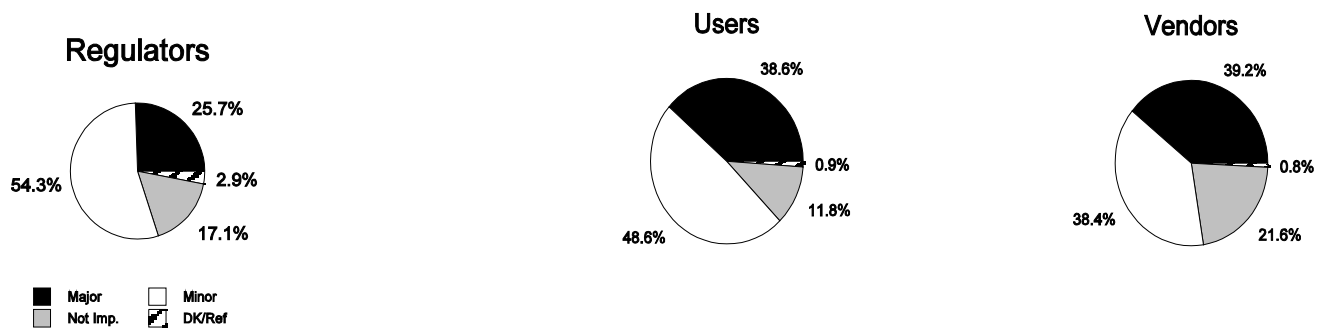
Lack of financial resources



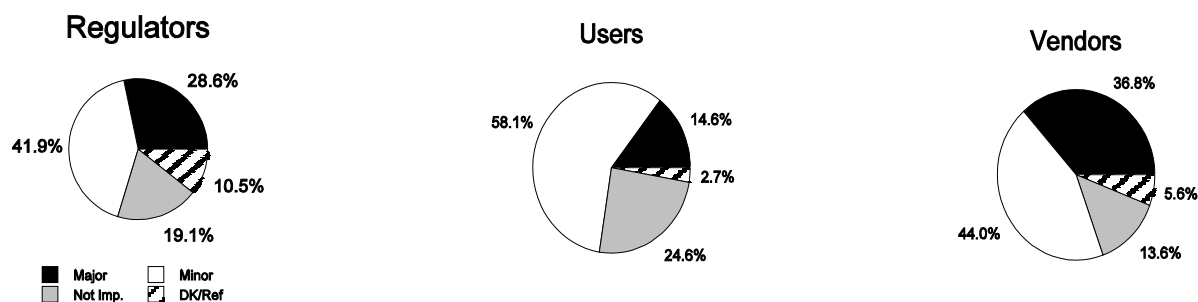
Lack of credible information on technology alternatives



Regulatory or permitting system



Business practices and related barriers to innovation



E. Regulatory Barriers

1. Views on importance of specific regulatory barriers

In this question the stakeholder groups were asked their opinion of a list of potential barriers drawn from previous reports on the subject of barriers to environmental technology innovation, such as those by the TIE committee of NACEPT. The strongly affirmative nature of the responses indicate that the barriers these reports identified: risk aversion, the lack of credible data, limited regulatory flexibility, added delays and uncertainty and the lack of reward for doing better -- are genuine.

Responses are shown in the following table and are strongly affirmatory to all the identified barriers in each of the stakeholder group, establishing a broad consensus on the barriers identified in previous studies. Over two-thirds of each group responded that each listed source of regulatory barriers is at least a minor barrier to environmental technology innovation, and with few exceptions at least a third of each group regard each barrier as major.

The highest number of both regulators and vendors view the major regulatory barrier as the lack of incentive to exceed minimum compliance, whereas users see it as the uncertainty and excessive length for permit approval and permit writers' inexperience. Vendors also view the lack of acceptance of new technologies as a major problem.

As in the previous question, each stakeholder group placed lesser emphasis on the barriers that derive from its own actions: regulators place less emphasis on barriers within the permitting system than do users or vendors, users place least emphasis on the lack of incentive to exceed minimum compliance, and vendors least emphasis on the need to test and implement their own technologies. There remains however significant agreement on the significance of these barriers, many inherent in the way rate-base systems operate.

Table 5. Responses indicating major regulatory barriers

	<u>Regulators</u>	<u>Users</u>	<u>Vendors</u>
Lack of incentive to exceed min. compliance	57%	36%	62%
Uncertainty, excessive length for permit approval	38%	59%	40%
Permit writers inexperience	31%	53%	48%
Too little time for testing and implementing	31%	49%	26%
Lack of new technology acceptance	18%	29%	43%

After being asked about specific barriers, respondent were asked whether they could think of other barriers to innovative technologies. Although the majority of each group could not, some from each stakeholder group suggested other barriers. The leading responses included 6 % of regulators who indicated that other barriers included either regulation specific problems or lack of data, and 5 % of users and 10 % of vendors who responded that regulators are uncooperative and are, therefore, a barrier.

2. Views on federal or state origin of regulatory barriers

Table 6. Identification of federal or state statutes, regulation or permits as source of major barriers.

	<u>Regulators</u>	<u>Users</u>	<u>Vendors</u>
Federal regulations	37%	41%	39%
Federal statutes	29%	33%	34%
State permits	10%	40%	32%
Federal permits	12%	31%	30%
State regulations	12%	31%	28%
State statutes	6%	28%	18%

A significant majority of all groups felt that each of the six components are a source of at least minor barriers to innovative environmental technologies. There was also consensus as to the chief source of barriers, as everyone agreed that federal regulations create the most significant barriers, and all groups also felt that federal statutes also create important barriers.

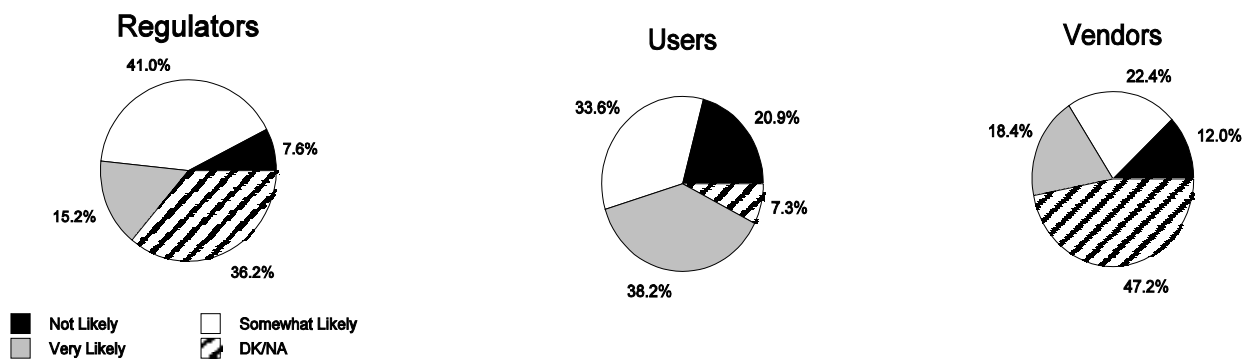
The difference between the stakeholder groups is however notable when it comes to state permits, which are considered a major barrier by many users and vendors, but only by 10% of regulators. The lack of emphasis on state permits may be due in part to the nature of the regulators interviewed, all state permit officials. In this regard, the responses of the users and vendors may be more impartial, and indicate that state permitting creates equivalent barriers as federal statutes and regulations. This would make sense, as federal regulatory requirements are traditionally carried out by state permit authorities.

The chief difference among the groups is that while regulators placed equivalent priority on federal regulations and statutes as a major source of barriers, less than 12% identified the other components as the source of major problems. Users and vendors on the other hand perceive that all the components create barriers, with roughly a third stating that they create major barriers, and 80% that they create at least a minor barrier. Their response is slightly weaker for federal permits and state statutes.

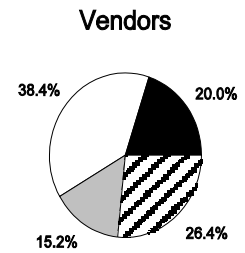
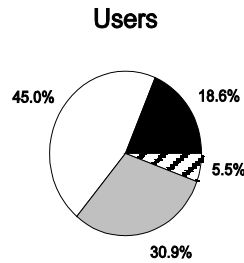
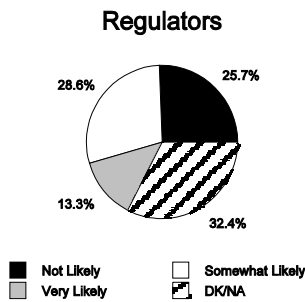
3. Barriers caused by regulatory systems for different media

Table 7. Regulatory systems by media which are likely to impose a barrier to using innovative technology

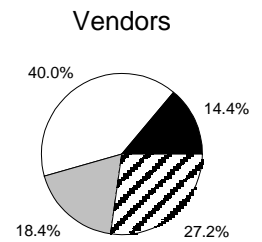
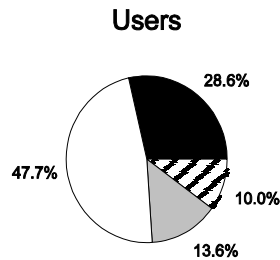
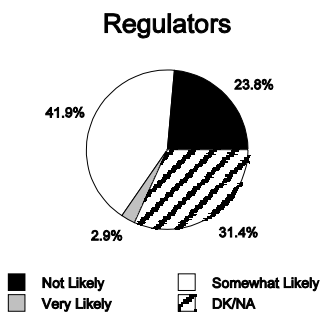
Solid or hazardous waste.



Air:



Water:



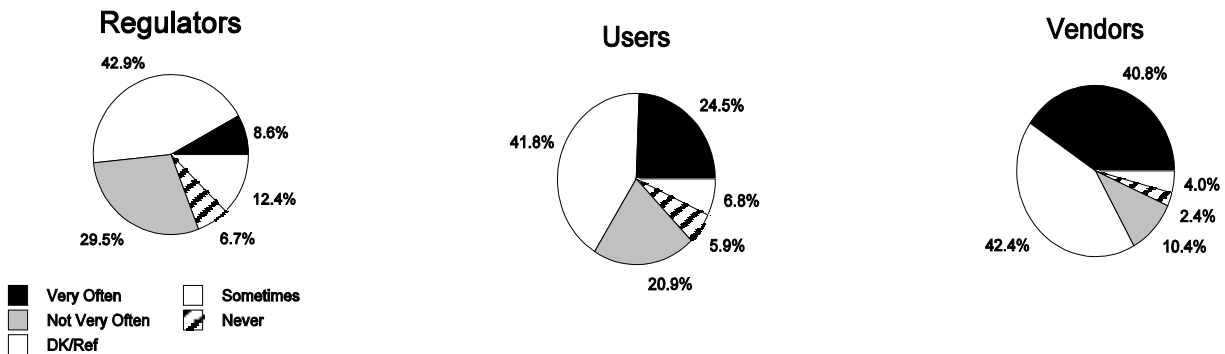
Responses were uniformly strong that regulatory systems for each media were at least somewhat likely to give rise to barriers. In addition, all groups agreed that barriers were most likely to arise from the systems regulating solid or hazardous waste.

While responses were comparable between groups that the regulatory systems for each media would be somewhat likely to create barriers, users and vendors felt more strongly than regulators that the regulatory systems for all three media would be very likely to create barriers to innovative technology.

The high incidence of respondents, especially regulators and vendors, stating they could not respond for a particular medium indicates the understandable specialization needed by regulators under our media-specific statutory regime, and by the nature of technologies to address particular media pollutants.

4. **How often do companies not pursue promising innovative technology because of the uncertainty of its complying with the environmental regulations or permitting**

Table 8. Responses indicating how often companies do not pursue innovative technology because of uncertainties with environmental regulations or permitting



Responses among groups varied dramatically when asked how often companies decide not to pursue a promising innovative technology because of the uncertainty of its complying with environmental regulations or permitting. Forty percent of vendors responded very often, compared to 25 % of users and only 9 % of regulators.

One explanation for this difference is that users have the most accurate assessment, and that vendors exaggerate this problem while regulators underestimate it. Another is that possibly each group may act to screen the technologies for the other groups. Vendors are the first to consider various innovative technologies for development, and may be expected to have the highest frequency of dismissing them for compliance uncertainty. Users are the next to review the technologies, and regulators the last, and therefore may have correspondingly lower rejection rates. This would indicate that users and especially regulators are not aware of the number of potential innovative technologies that are being rejected due to the barriers involved, and are never presented for their review.

5. **Changes in the regulatory system that would be helpful in promoting the use of innovative technologies**

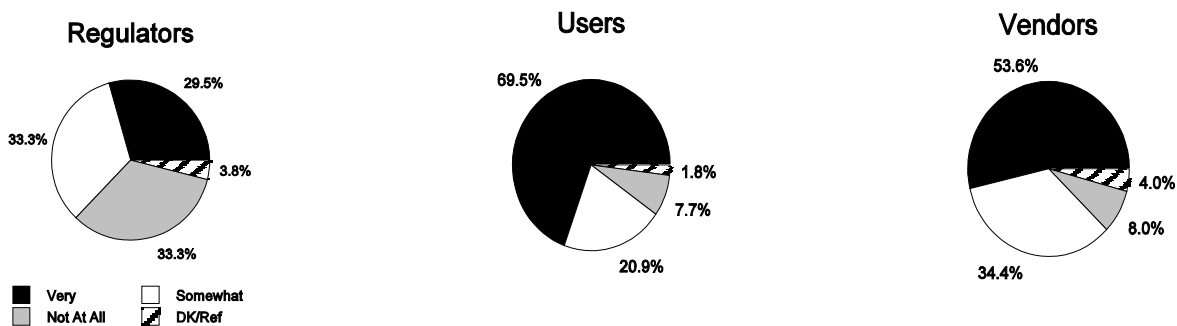
The stakeholder groups were asked to evaluate the changes in the regulatory system which have been identified in previous literature, such as the TIE committee reports, as important to promote the use of innovative environmental technologies.

The response was overwhelmingly affirmative, with at least a third of respondents finding **each** change to be very helpful, and generally over 75 % of each group finding the changes to be at least somewhat helpful. The only weaker responses came from regulators, about a third of whom thought

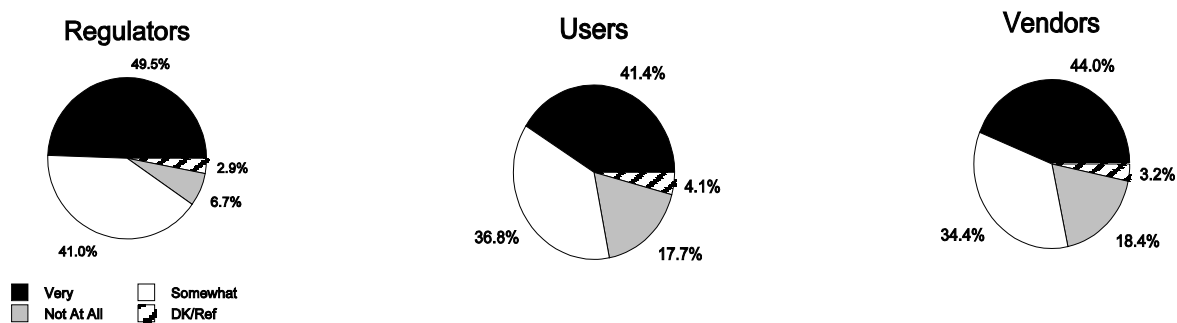
that reducing delays in the permitting systems, multimedia permitting, and more consistent enforcement were "not at all" helpful.

Table 9. Responses indicating that changes would be very helpful in promoting the use of innovative technologies

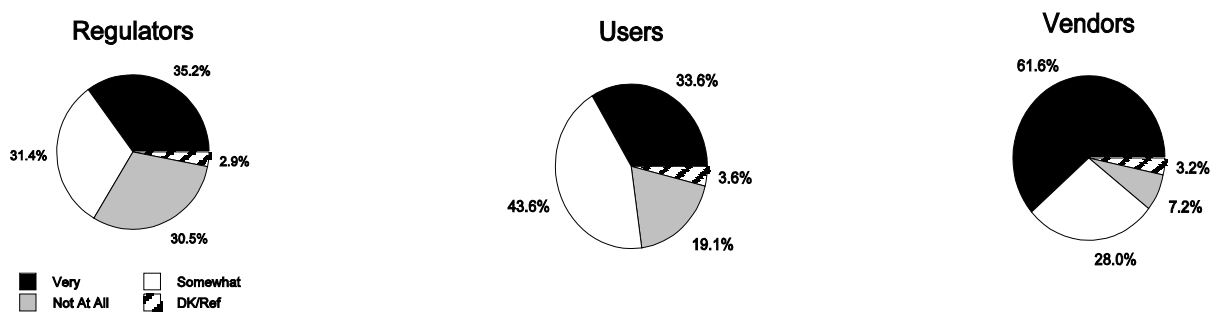
Reducing delays in permitting:



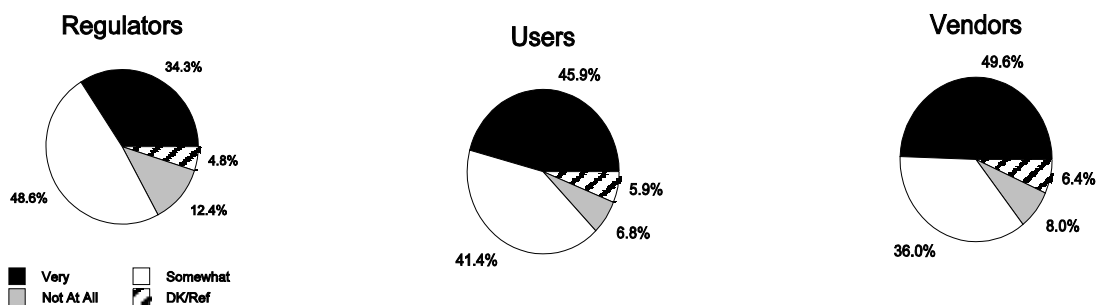
Government-sponsored technology verification and demonstrations:



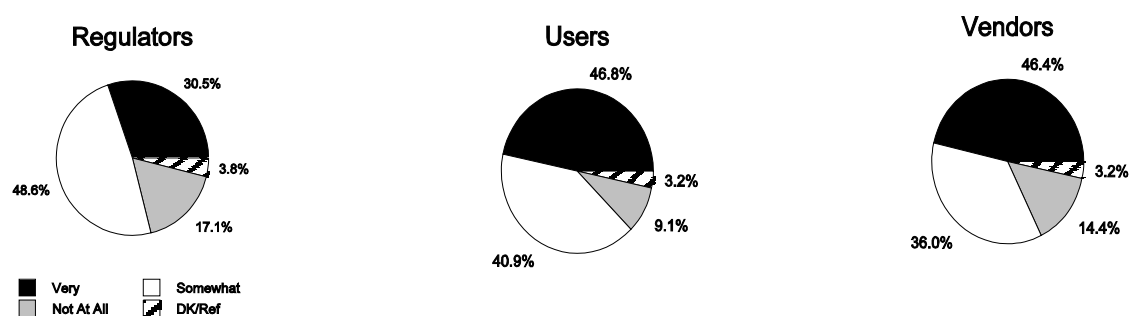
More consistent enforcement:



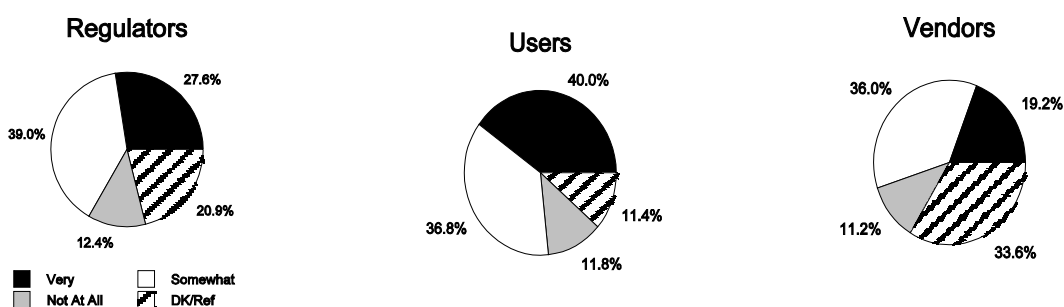
Change from technology-based to overall performance standards:



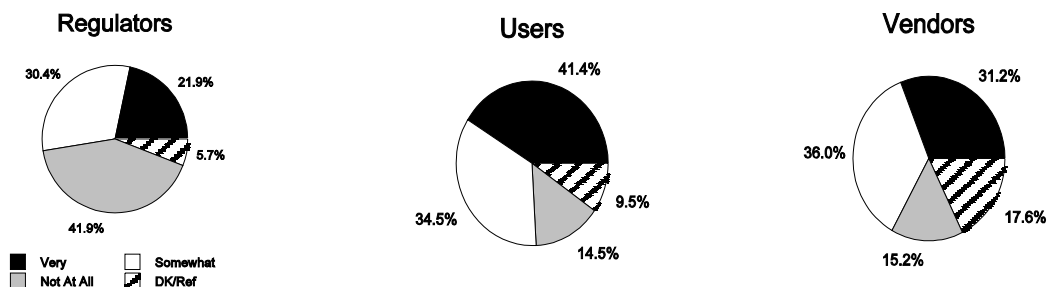
Special treatment for innovative technologies:



Instituting bubbles or caps for multiple emission sources:



Multimedia permitting



Users had a hard time finding anything they didn't like, with an emphatic 70 % believing that reducing delays in the permitting system would be "very helpful", the highest response to any question. Many users, generally over 40 %, also perceived each of the other changes to be "very helpful".

The sharp differences in opinion between regulators and users is especially evident in these questions. Views on delays caused by the permitting system are especially notable: while two thirds of users view reducing delays in the permitting system as very important to their use of innovative technologies, two thirds of regulators saw this as only somewhat or not at all important.

Vendors likewise voted strongly for all the suggested changes, but showed greater preferences for certain changes. Vendors gave greatest importance to more consistent enforcement, apparently linking this to demand for their products. Vendors also gave strong endorsement to reducing delays in permitting and a change from technology-based to overall performance standards.

Regulators consistently placed lesser emphasis on changes to the permitting system than users or vendors. The average response of regulators to the six changes regarding the permitting system was an average of 15% lower than the other groups, and 30 % in the case of reducing delays, suggesting that they do not perceive the permitting system as great a problem as do vendors or users. Regulators placed greatest emphasis instead on government sponsored technology verification and demos, reinforcing earlier findings about regulators' perceived need for better data.

6. Suggested changes to the regulatory or permitting system to further promote the use of innovative technologies

When asked whether they could suggest changes to the regulatory or permitting system that would promote the use of innovative technologies, about 60 % of each group made suggestions. Although a wide variety of changes were suggested, regulators most commonly answered that more flexibility (26 %) and greater incentives (13 %) were needed. Users most frequently chose better communications between the regulated and regulators (23 %), more flexibility (17 %), and more knowledgeable regulators (14 %) as changes needed to promote innovative technology. Vendors most frequently chose increased incentives (17 %), more knowledgeable regulators (12 %) and government technology verification programs (12 %).

7. Cost savings from eliminating regulatory barriers

Respondents were asked what percentage of current compliance costs they thought could be saved if there were no regulatory or permitting barriers to implementing innovative environmental technologies. About half of all groups agreed such savings would be substantial, on the order of 25 % or more. Users and vendors estimated such savings as only slightly higher than regulators.

Table 10. Perceived cost savings if barriers to innovation removed

	None	10% or less	10-23%	24-30%	more than 33%
Regulators	9.52%	23.81%	19.05%	33.33%	14.29%
Users	10.24%	17.47%	18.07%	28.92%	25.30%
Vendors	3.90%	12.99%	27.27%	27.27%	28.57%

F. Financial and Internal Barriers

1. Perceived importance of specified barriers which are unrelated to the regulatory system

The stakeholder groups were asked to evaluate the importance of barriers unrelated to regulatory barriers. This question asked about barriers identified in past literature, including financial barriers and those internal to the company.

Again, the response was overwhelmingly affirmative, with almost 50 % of respondents believing most of these barriers are major, and over 85 % believing them at least minor. To a greater degree than for the questions concerning regulatory barriers, responses were also fairly consistent between the stakeholder groups.

Table 11. Responses indicating major non-regulatory barriers.

	REGULATORS	USERS	VENDORS
Lack of credible data on a technology's cost or performance	75	50	62
Financing for innovative technologies not being available	54	54	61
Lack of financial benefits or rewards for using an innovative technology	47	51	65
Company staff not having enough time to make an assessment of technical options	44	55	54
Lack of information on the availability of innovative technologies	62	33	49
Large investments in technologies in place prevent the selection of new technologies	56	41	42
Company staff preferring end-of-pipe solutions to environmental requirements	35	20	32

Responses from all stakeholder groups were uniformly strong that virtually all the specified barriers are important. Leading the list are: the lack of credible data on a technology's cost or performance; the lack of financing for innovative technologies; and the lack of financial benefits or rewards for using an innovative technology. However, these are closely followed by: company staff not having enough time to make an assessment of technical options; lack of information on the availability of innovative technologies; and large investments in technologies in place prevent the selection of new technologies.

An interesting finding is that the weakest response in all groups was in regard to the proposition that company staff prefer end-of-pipe solutions to environmental requirements, which was viewed as only a minor barrier by all groups. This may be a testament to how much businesses' environmental compliance systems have moved away from an end-of-pipe focus, which was considered a major problem in prior decades.

Another interesting finding is the emphasis on lack of financial reward for using an innovative technology, given the significant cost savings from innovation that stakeholders identified in the previous question. This may indicate that while there is little financial reward to innovation in our current regulatory system, there is considerable potential for cost savings if regulatory barriers could be removed.

A notable difference among stakeholder groups is the extremely high value placed by regulators on credible data and information about a technology. A very high 75 % of regulators identify lack of credible data as a major concern, the highest response for any barrier, and 62 % perceived lack of information on the technology availability as a major barrier. For both, only 1 % of regulators thought these were not important, overall the strongest response for any question. For other barriers, the response is fairly uniform, although vendors believe somewhat more strongly than the others that the lack of financing and lack of financial benefits for using an innovative technology is a major barrier.

An interesting result here is that more regulators than users or vendors perceive that large investments in technologies in place may prevent the selection of new technologies, even though the latter might be expected to have better information. One explanation may be that regulators are being told this by the industry representatives to a greater degree than it is true.

When asked, only a minority of each group could think of other non-regulatory barriers in addition to those listed. Of the 20 % or so that could, the fear of fines and the cost to replace technology were the leading overall responses, with vendors also citing a lack of money as a barrier.

2. **Difficulty of obtaining financing for innovative environmental technology compared to standard environmental technologies**

Table 12. Percentage who feel it is more difficult to obtain financing for innovative environmental technology compared to standard environmental technology

Regulators	56%	Users	42%	Vendors	47%
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Responses to this question indicate financing is perceived as a major barrier to innovative technologies by all groups. About 50 % perceive it is more difficult to obtain financing for innovative technologies, and the great majority of all groups feel that it is at least as difficult to obtain financing. Less than five percent of each groups think such financing is easier to obtain.

**G. Information and sources for environmental technology
(regulators and/or users only)**

1. *Sources of environmental technologies*

When users were asked where the environmental technologies that their firm uses come from, two thirds identified independent vendors, indicating the importance of this community to users regarding environmental compliance issues. The one-half of companies that rely on their own research indicates the importance of this source and may indicate an emphasis on internal process changes as a compliance strategy. When asked to think of other sources, consultants and trade associations were mentioned.

Table 13. Sources of environmental technologies used by firms.

Independent technology vendors	67%
Contractors to your company	64%
Your company's own research and development	55%

2. *Information resources*

When asked about specific information sources, most users and regulators found them at least somewhat useful, often by large majorities. The only exceptions were small businesses assistance programs, which were found by most users and regulators not to be useful, due to their specialized nature, and customers, which were found by most users and a quarter of the regulators not to be useful.

As to the most useful resources, both groups place highest importance on industry and trade association publications and conferences as an information source. Regulators placed next greatest importance on government technical assistance offices and university and extension programs, although only one-quarter of the users rated this as very useful and one quarter as not at all useful. Users instead place greater reliance on industry: half of users found outside consultants or contractors very useful, and a third regard other companies, their own research, or vendors and suppliers as such. When asked to think of other resources for information or technical assistance, a large number of those responding mentioned the Internet.

Table 14. Information resources considered "very" useful

	<u>Users</u>	<u>Regulators</u>
Industry trade associations, publications, or conferences	63%	52%
Government technical assistance office, university, or extensions programs	24%	58%
Your facility's employees or own research	38%	43%
Outside consultants or contractors	48%	24%
Other companies	39%	33%
Vendors and suppliers	34%	27%
Customers	9%	25%
Small business assistance program	6%	10%

The fact that both businesses and regulators are accessing a wide range of information sources should be taken into account in framing technology policy, as well as in considering the responses of regulators in earlier questions that lack of information is a major barrier.

H. Miscellaneous

1. *Annual compliance costs*

When asked to estimate their facility's annual environmental compliance costs users gave a wide range of answers, presumably according to the size of the operation. Approximately an equal number, or one-fourth of users answered their compliance costs were in the following categories: \$75,000 or less; \$76,000 to 350,000; \$360,000 to \$2 million; and \$2 million or over.

2. *Vendor company practices in research and development*

Almost 50 % of vendors are spending more on research and development over the past three years, compared to 17 % who report spending has decreased. When asked to identify the primary

source of their company's research and development, 72 % identified their own staff, followed by the following sources:

Table 15. Primary sources of vendor research and development

Company staff	71.90%
Other companies	11.57
Parent company	4.13
Universities	3.31
Government research	3.31
Other	4.96

3. *Vendor Liability concerns*

More than 67 % of vendors responded that liability concerns have not discouraged vendors from developing, selling, or licensing an innovative technology in favor of an older more established approach, while about 25 % responded that such concerns are barriers. When asked about specific liability concerns, vendors rated each more as minor barriers than major ones.

Table 16. Liability concerns identified as major by vendors

39%	The fear of being sued by users if a technology fails
34%	The cost of product liability insurance
24%	Time demands in dealing with liability issues
19%	Difficulty in developing technologies jointly through partnerships

APPENDIX A RESEARCH METHODOLOGY

A.1. SUMMARY

This study was intended to identify barriers to innovative environmental technologies, drawing heavily on potential barriers identified in past research. The results also reveal differences in perceptions of barriers between the various stakeholder groups. The survey was administered to three stakeholder groups: state environmental agencies, regulated facilities, and firms selling, leasing or recommending environmental technologies. Abt Associates administered the survey, and approximately 460 interviews were completed. Abt Associates then cleaned, weighted and developed confidence intervals for the data, which are presented in the above graphs.

A.2. SAMPLE SELECTION

Initially, five stakeholder groups were identified for surveying: 1) individuals who set permit requirements and approve permit applications in state environmental agencies, 2) environmental managers in regulated facilities, 3) vendors of environmental technologies, 4) individuals and CEOs of companies providing financing for environmental technologies, and 5) individuals from environmental organizations who are knowledgeable about innovative environmental technology issues.

Ultimately, the survey was administered to only the first three stakeholder groups listed above. Although a list of environmental technology financiers who have operated in the U.S. was obtained from a private firm that compiles databases of individuals and companies in the environmental field, the list was abandoned early in the survey implementation period after it was determined that the majority of individuals contacted no longer financed environmental technologies, were out of business or not available. The lack of identifiable financiers investing in environmental technology is itself a significant finding, and reinforces the conclusion about the lack of available finance presented in part 2B above. A comprehensive list of individuals in environmental organizations with knowledge of innovative technologies was not obtainable. For qualitative research, the questionnaire was administered to several individuals identified by ELI, however, since this sample has little statistical validity, the results are not presented.

Regulators

The names and contact information for regulators involved with approving innovative environmental technologies was compiled from lists provided by the Association of State and Territorial Solid Waste Management Officials (ASTSWMO), the Association of State and Interstate Water Pollution Control Administrators (ASIWPCA), and the Association of Local Air Pollution Control Officials (ALAPCO). The list of state regulators consisted of one divisional chief or head of permitting of the air, water, and solid/hazardous waste division from each state environmental agency. Added to this list were 15 individuals heading up state multimedia permitting programs. This resulted in a universe (not sample) of the 165 individuals in each state air, water, or solid/hazardous waste

regulatory program considered to be the most knowledgeable or experienced in the issues surrounding state regulatory approval of innovative environmental technologies.

Users Sample

The sample of regulated facilities (or potential users of environmental technologies) was generated from the various EPA program office databases. The names and addresses of facilities holding one or more "major" air, water, or hazardous waste permits (as defined by each of these media programs) were obtained using the Agency's Integrated Data for Enforcement Analysis (IDEA) system and EPA's Facility Indexing System (FINDS) which links the media databases (e.g. Clean Air Act - CAA, Clean Water Act - CWA, Resource Recovery and Conservation Act - RCRA) at the facility level, in addition the D&B database. The linkages contained in IDEA are based on an address-match established by EPA's Facility Indexing System (FINDS).

Over 42,000 facilities were identified as having one or more major permits. Facilities ranged from having a single major permit to having one or more permits in all three media databases. The table below shows the seven possible combinations of permits held by a facility (column A). Because major permits are defined differently within each program office permit program, there were far more facilities with major air permits than major water or hazardous waste permits (column B). Most of the "major" permit universe is permitted only for air permits.

A	B	C	D	E
Stratum	Number of Facilities in the Population	Equal Allocation for Each Stratum	Allocated in Direct Proportion	Allocated in proportion to the 2/3 power of stratum population
Air, Water and RCRA	523	188	16	46
Air and Water Only	1,099	188	34	76
Air and RCRA Only	1,335	188	41	86
Water and RCRA Only	168	188	5	22
Air Only	30,728	188	953	707
Water Only	4,546	188	142	197
RCRA Only	3,992	187	124	181
Total	42,391	1,315	1,315	1,315

A number of different sample allocations were examined. The allocations presented above have been adjusted appropriately to reflect the total of 1,315 technology user sample records actually used in the survey. (In the course of administering this survey, much of this sample was determined to be out of scope of the study or could not be reached.)

Because the stratum of facilities with only a major air permit was almost seven times higher than the next largest stratum (and 180 times larger than the smallest stratum), a sample made up of facilities allocated from each stratum based on the direct proportion of the stratum size (column D) would result

in a survey of mostly facilities with only air permits and little information would be gained from those facilities holding water and RCRA permits. On the other hand, allocating an equal number of facilities from each of the seven combinations would result in a sample that was not representative of the regulatory burden on facilities (column C).

It was decided that a compromise allocation between the two extremes described above would better represent the more rigorous air permit requirements while providing input on barriers from facilities with water and RCRA permits. As shown in the table above, two alternative allocations were examined known as power allocations. The selected option was to allocate the sample in proportion to the $2/3$ power of the number of facilities in each stratum (column E). The number of facilities in each of the seven strata was raised to the $2/3$ power and this number of facilities were randomly pulled from each stratum into a larger list from which the sample was drawn.

Vendors Sample

A list of individuals in companies that sell, lease, or recommend environmental technologies to regulated firms was obtained from Environmental Business International, a private firm that compiles databases of individuals and companies in the environmental field. According to this firm, the total population of such vendors in the U.S. is approximately 3,760. A sample of 360 was chosen randomly from this list.

A.3. PREPARATION OF THE SURVEY INSTRUMENT

The survey instrument was designed to collect as much information as possible while minimizing respondent burden in a telephone interview between 10 and 12 minutes in length. The survey questionnaire was developed with assistance from individuals from state and federal government and non-government organizations. Prior work on the issue such as a 1991 survey of hazardous waste generators conducted by the Wisconsin Department of Natural Resources and the U.S. EPA's Permits Improvement Team Task Force Recommendations were also reviewed.

The survey did not solicit detailed facility information but focused on respondents' recollection of recent experiences and opinions. Respondents were promised anonymity; individual and their organizations were never identified to EPA staff. They were also provided with a telephone number that they could call to request a copy of the survey results. Since barriers to technology innovation are often integral to facility operations, particular efforts were made in the wording and sequencing of questions to minimize respondent bias associated with anticipating "correct" answers. Several iterations of the survey were circulated to individuals within federal and state regulatory agencies, the private sector, academics, and non-government organizations.

Screening questions were used to ensure that the respondent was involved in the approval, use, or marketing of environmental technologies. For all three populations surveyed, it was critical to conduct the interview with individuals who have had some experience with innovative environmental technologies. After defining environmental technologies and innovative environmental technologies, a screening question asked if respondents had considered approving, using, recommending or selling innovative environmental technologies in the past five years. If not, they were asked why not, and then the survey was terminated. These respondents were considered to be out of scope, and were not counted as completed interviews. The questionnaires used for regulators, technology users, and

technology vendors differed only slightly in the wording of questions and, in the case of vendors, a series of questions on information sources was replaced with a series of questions on product liability.

A.4. PRETEST AND REVISIONS

A total of nine pretests were administered to technology users, vendors, and financiers. As a result of the pretest, the survey was revised to clarify certain parts of the questionnaire and a number of questions were shortened or eliminated to reduce the time required to participate. Similarly, lists of items used within several lines of questions were shortened by combining items. Finally, a number of wording and grammar changes were made to reduce the reading comprehension level required.

A.5. SURVEY ADMINISTRATION

(a) Survey protocols

The telephone survey was administered following well-tested protocols of a national survey group, with interviewers experienced in administering surveys of establishments. All interviewers were trained in the specific information needs of the study and were provided background on the types of facilities they would be contacting. Constant supervision was provided by senior survey research staff. The survey was recorded on survey questionnaires and records were kept on each attempt to reach a respondent. Sample of names and telephone numbers for the users and vendors sample groups were provided to the interviewers in batches, or replicates. This ensured that all efforts were made to obtain completed interviews with the sample in the replicate were made before additional sample was released. A maximum of eight attempts were made at reaching each potential respondent before the sample was coded as an incomplete.

(b) Disposition of Completed Survey

In total, there were 220 completes for the technology users, 125 completes for the technology vendors, and 105 completes for the permit writers. Response rates varied considerably between the sample groups. The response rate was best for the regulators universe at 76 %. The vendors sample group also had a good response rate of 52 %. The users group had the lowest response rate at 39 %. The table below provides the final disposition of all calls.

	Users	Vendors	Regulators
TOTAL SAMPLE	1,315	360	165
Unobtainable, not in scope, terminated after Question 2, or out of business	744	119	27
Subtotal	571	241	138
Completes	220 (39%)	125 (52%)	105 (76%)
Nonrespondent Subtotal	351 (61%)	116 (48%)	33 (24%)
Detailed Disposition of Unobtainable/Ineligible Sample			
No eligible respondent at location	127	51	0
Facility claims to be unregulated or no longer regulated	10	0	0
No listing for facility in directory assistance or D&B	387	15	0
Out of business	31	7	0
Military or government facility	99	0	0
Duplicate respondent	8	3	0
Terminated at Question 2 (Respondent had not considered innovative technologies in past 5 years)	82	43	27
Detailed Disposition of Nonrespondents			
No answer, answering machine, busy, or requested call back on last attempt*	112	54	10
Break off	4	0	2
Respondent not available during study	24	1	0
Gatekeeper refusals	18	16	1
Other refusals	193	45	20

* *A maximum of eight attempts were made to reach each respondent.*

The primary reason for the lower response rate in the users sample group is the relatively high rate of refusals from potential respondents. The high refusal rate in this stakeholder group (211 refusals) was not unexpected. It is common for managers at industrial facilities to refuse to participate in surveys at a higher rate than other types of respondents since their duties often take them onto the plant floor or grounds away from telephones and quiet spaces for answering the questions. Another contributing factor to the relatively low response rate was that the environmental managers at regulated facilities were not easily reached. At 112 facilities, potential respondents were unreachable or were not able to take

part in the survey after attempting to reach them eight times.

Although it does not affect the overall response rate, it should be noted that a significant portion of the technology users sample was found to be out of scope of the survey or may no longer be in business. Most of these (387 of the 1,315 facilities in the sample) were facilities for which telephone numbers were not found by the commercial telephone number look up service, and for which there were no listings in the D&B database or in directory assistance. Another important group of ineligible sample were government and military facilities (99 of the 1,315 facilities). These facilities were not screened out of the original sample, and the decision to exclude such facilities was made after the sample was obtained. Government and military facilities, therefore, were screened out of the sample by the telephone interviewers based on the facility name and facility descriptions given on the telephone. These facilities were excluded because the organizational structure and non-profit nature of these facilities would be expected to result in a very different set of issues driving the use barriers to innovative environmental technologies than would be faced by for profit industrial facilities. The survey questionnaire was not developed with these facilities in mind and likely would not have identified many of the barriers faced by these facilities.

A.6. POST-SURVEY WEIGHTING

There is a basic sample selection weight for each establishment in the sample that is considered a completed call. This weight is derived by taking the ratio of the number of establishments in a stratum population, divided by the number of establishments selected in the sample. This denominator includes completes, Nonrespondents, out of business, and so on. Although the samples were given these weights to represent the overall populations of each group, these weights would only affect the results when combining the results of all three sample groups into one large group. Combining the sample groups into one large group is not expected to be an effective tool in analyzing the survey results. The size of the users population (over 42,000) is disproportionate compared to the population of permitting program chiefs (165) and population of environmental technology vendors (3,760). Therefore, when grouped together, the results of the users group will obscure the results of the permittees and vendors groups. Instead, results are presented and analyzed separately for each of the three groups surveyed.

A.7. POST-SURVEY STATISTICAL TESTING OF CORRELATIONS AND RESULTS

The weighted frequencies (or proportions) presented in the findings section of this report were calculated for the responses to each question using the SAS statistical software package. Standard errors of the estimates depend on the sample size and the sample design used for the survey. Standard errors were not derived for the regulators group because this group was comprised of the most senior person available in each permitting program. Since the entire population of such individuals was surveyed, therefore there is no sampling error. For computing the standard errors for the technology users and vendors groups, the Survey Data Analysis software (SUDAAN, developed and maintained by Research Triangle Institute) was used. Standard errors were then used to calculate the 95 percent confidence interval for each question. (The 95 percent confidence interval is calculated by multiplying the standard error by 1.96.) This is the range in which one can be 95 percent confident that the actual results would be within if the entire population had been surveyed.

Standard errors were calculated for each possible response to a question (e.g. major, minor, not

important, and don't know or no answer - DK/NA). The confidence interval for a response becomes larger as the portion of the sample giving a particular response approaches 50 percent and decreases as that portion approaches 0 and 100 percent. Only the widest 95 percent confidence intervals for each question and sample group (users and vendors) are presented in the summary of results in Appendix B. For each question, the 95 percent confidence interval of other possible responses are the same or smaller than the presented confidence interval.

Standard errors and 95 percent confidence intervals were not calculated for those questions in which respondents provided open-ended answers or estimated quantities. One example is Question 7, where respondents were asked to name additional ways that the regulatory system hinders the consideration of innovative environmental technologies. Since only about 30 percent of respondents provided additional information, and the open-ended responses were coded into nine different answers, the number of responses for each possible answer are very small and therefore result in large standard errors and confidence intervals. Responses to such questions should, therefore, be viewed as qualitative survey findings.

A.8. LIMITATIONS TO THE SURVEY

In interpreting these results, it is important to understand the various limitations inherent in the design and execution of the survey. Because it is not feasible to survey every single stakeholder, the survey was conducted by means of a sample and is thus subject to the limitations which go along with such surveys.

One of the primary goals of this study was to obtain comparable data from a number of stakeholder groups. The three groups studied had very different characteristics which required the use of three different sources of sample. While the vendors and users sample were chosen randomly from databases as described in Section A.2, the regulators contacted were the most knowledgeable permitting staff in each state permitting office. Therefore, the results of the regulators survey should not be applied to the entire population of regulators or permit writers in the U.S.

Standard sampling errors are also estimated for each question using the Survey Data Analysis software (SUDAAN) developed and maintained by Research Triangle Institute. From the standard error, 95 percent confidence interval were calculated and are presented in the summary of results in Appendix B. The 95 percent confidence interval indicates 95% confidence that the actual response from the entire population would be contained in the interval obtained by taking the estimated percentage based on the sample and plus or minus the numbers shown in the table.

Another limitation of this survey and most surveys that should be considered is the effect of nonresponse. A certain percent of the sample in each target group could not be reached during the survey period, or chose not to participate in the survey. Response rates, and efforts to maximize response rates, are discussed in detail for each group in above sections. Since it is possible that the nonrespondents are in some ways different from the respondents, it is also possible that, if every individual was available and participated, the survey results would be significantly different. This nonresponse bias is impossible to quantify without collecting further data from the Nonrespondents.

APPENDIX B

ENVIRONMENTAL TECHNOLOGY BARRIERS SURVEY

RESULTS

WHEN CALL IS ANSWERED, SAY:

Could I please speak with the person in charge of environmental compliance at this facility?

WHEN CONNECTED TO ELIGIBLE RESPONDENT, READ INTRODUCTION

Hello, my name is _____. I'm calling from Abt Associates, a national research company. We are conducting a confidential survey of environmental permit writers/managers at manufacturing facilities/vendors of environmental technologies nationwide. [We are interested in learning what things affect environmental planning and decision-making at your facility and impediments to technological innovation.] There are no correct answers -- we want to record your experiences accurately. Just to confirm that I'm talking to the right person, are you involved in evaluating the permit applications and environmental technologies of industrial facilities/planning for and implementing environmental compliance decisions, such as permit application and technology evaluations/recommending, selling or leasing of environmental technologies?

YES (CONTINUE)

NO (ASK FOR NAME AND PHONE NUMBER OF APPROPRIATE PERSON; RECORD AND ASK TO BE TRANSFERRED. WHEN CONNECTED, READ INTRODUCTION.)

The study is sponsored by the Environmental Law Institute and the U.S. Environmental Protection Agency. Participation is voluntary and your answers will be kept in strictest confidence. Only summary information of the results will be reported.

When I refer to **environmental technologies**, I am including monitoring equipment, treatment and control devices, pollution prevention technologies and even process modifications if they are installed to improve environmental performance. When I refer to **innovative environmental technologies**, I mean any system of pollution prevention or control that *has not been demonstrated in practice*, and that could achieve greater environmental protection than traditional technologies or that could achieve comparable environmental protection, but at a lower cost.

1. In the past five years, how many times have **you yourself** considered approving/ implementing/recommending, selling, or leasing specific **innovative** environmental technologies, as I have just defined it? Would you say...

	Never	Once	2-3 times	>,=4 times	DK/Ref
Regulators	20.45	15.91	30.30	31.06	2.27
Users	27.15	18.54	31.13	21.52	1.66
Vendors	25.60	7.14	10.12	57.14	0.00

Max 95% c.i.: Users = $\pm 5.17\%$; Vendors = $\pm 7.15\%$

IF ONE OR MORE, SKIP TO Q.3

2. Why haven't you considered approving/using/sold, leased, or recommended any **innovative** environmental technologies? Is it because there was:

None proposed/No need for a new technology/No market for a new tech.

	Yes	No/DK/Ref
Regulators	77.78	22.22
Users	51.22	48.78
Vendors	25.58	74.42

Max 95% c.i.: Users = $\pm 10.86\%$; Vendors = $\pm 13.09\%$

A problem with the regulatory or permitting system

	Yes	No/DK/Ref
Regulators	7.41	92.59
Users	16.27	83.72
Vendors	12.20	87.80

Max 95% c.i.: Users = $\pm 7.11\%$; Vendors = $\pm 11.09\%$

A lack of credible information on technology alternatives

	Yes	No/DK/ Ref
Regulators	7.41	92.59
Users	53.18	44.55
Vendors	26.83	73.17

Max 95% c.i.: Users = $\pm 9.62\%$; Vendors = $\pm 12.21\%$

No suitable technology available to the best of your knowledge

	Yes	No/DK/ Ref
Regulators	3.70	96.30
Users	53.18	44.55
Vendors	34.88	65.11

Max 95% c.i.: Users = $\pm 10.02\%$; Vendors = $\pm 14.31\%$

A lack of financial resources or time

	Yes	No/DK/ Ref
Regulators	7.41	95.29
Users	19.51	80.49
Vendors	25.58	74.42

Max 95% c.i.: Users = $\pm 8.60\%$; Vendors = $\pm 13.09\%$

Another barrier within your office/the business or company itself

	Yes	No/DK/ Ref
Regulators	0.00	100.0
Users	3.66	96.34
Vendors	6.98	93.02

Max 95% c.i.: Users = $\pm 4.08\%$; Vendors = $\pm 7.64\%$

Any other reason?

	Yes	No/DK/ Ref
Regulators	14.81	85.19
Users	6.10	93.90
Vendors	44.19	55.81

Max 95% c.i.: Users = $\pm 5.19\%$; Vendors = $\pm 14.91\%$

If yes, what are they

	inn.tech not scope	business too small	inn.tech too expen	DK/NA
Regulators	0.00	0.00	0.00	14.81
Users	2.44	1.22	1.22	1.22
Vendors	41.86	0.00	2.33	0.00

TERMINATE

3. Can you name any **innovative** environmental technologies that you considered approving/ could potentially be applied to your operations (**regulators and users only**)?

(Number of technologies listed)

	0	1	2	3	4	5	7	8
Regulators	23.81	32.38	27.67	9.52	3.81	2.86	0.00	0.95
Users	20.91	31.36	19.55	12.27	3.64	4.09	7.73	0.45

4. In the past five years, **have you personally** encountered any barriers or difficulties to a business moving forward with/marketing an **innovative** technology that you were considering?

	Yes	No	No/DK/ Ref
Regulators	52.38	42.86	4.76
Users	53.18	44.55	2.27
Vendors	71.20	28.80	0.00

Max 95% c.i.: Users = $\pm 6.57\%$; Vendors = $\pm 7.80\%$

5. [In terms of your industry in general,] how would you rate the following types of barriers to/to facilities using **innovative** environmental technologies? Is (READ ITEM) a major barrier, a minor barrier, or not a barrier at all to your industry?

The regulatory or permitting system

	Major	Minor	Not Imp.	DK/Ref
Regulators	25.71	54.29	17.14	2.86
Users	38.64	48.64	11.82	0.91
Vendors	39.20	38.40	21.60	0.80

Max 95% c.i.: Users = $\pm 6.59\%$; Vendors = $\pm 8.41\%$

The lack of credible information on technology alternatives

	Major	Minor	Not Imp.	DK/Ref
Regulators	54.29	36.19	7.62	1.90
Users	32.73	41.36	25.00	0.91
Vendors	33.60	44.00	20.00	2.40

Max 95% c.i.: Users = $\pm 6.49\%$; Vendors = $\pm 8.55\%$

The lack of financial resources

	Major	Minor	Not Imp.	DK/Ref
Regulators	34.29	35.24	15.24	15.24
Users	43.64	37.73	17.73	0.91
Vendors	49.60	36.00	13.60	0.80

Max 95% c.i.: Users = $\pm 6.53\%$; Vendors = $\pm 8.60\%$

Business practices and related barriers to innovation

	Major	Minor	Not Imp.	DK/Ref
Regulators	28.57	41.90	19.05	10.48
Users	14.55	58.18	24.55	2.73
Vendors	36.80	44.00	13.60	5.60

Max 95% c.i.: Users = $\pm 6.51\%$; Vendors = $\pm 8.55\%$

Regulatory Barriers

6. You may feel that the regulatory system impacts your [industry's] ability to consider/market an **innovative** compliance strategy. Some people have suggested the following as possible regulatory barriers to innovative environmental technologies. Do you consider (READ ITEM) to be a major barrier, a minor barrier, or not a barrier at all to your industry?

Lack of acceptance of new technologies within the permitting or regulatory process

	Major	Minor	Not Imp.	DK/Ref
Regulators	18.10	56.19	24.76	0.95
Users	29.09	50.00	18.18	2.73
Vendors	43.20	42.40	13.60	0.80

Max 95% c.i.: Users = $\pm 6.59\%$; Vendors = $\pm 8.53\%$

Having too little time to test and implement a new technology before new environmental requirements go into effect

	Major	Minor	Not Imp.	DK/Ref
Regulators	31.43	45.71	16.19	6.67
Users	48.64	33.64	15.00	2.73
Vendors	26.40	40.80	31.20	1.60

Max 95% c.i.: Users = $\pm 6.59\%$; Vendors = $\pm 8.47\%$

Permit writers' inexperience or unfamiliarity with the issues

	Major	Minor	Not Imp.	DK/Ref
Regulators	31.43	60.00	7.62	0.95
Users	52.73	30.91	15.45	0.91
Vendors	48.00	33.60	12.00	6.40

Max 95% c.i.: Users = $\pm 6.59\%$; Vendors = $\pm 8.60\%$

Lack of incentive for regulated facilities to go beyond minimal compliance with the requirements

	Major	Minor	Not Imp.	DK/Ref
Regulators	57.14	28.57	10.48	3.81
Users	36.36	40.91	20.00	2.73
Vendors	61.60	25.60	10.40	2.40

Max 95% c.i.: Users = $\pm 6.47\%$; Vendors = $\pm 8.37\%$

The uncertainty or excessive length of permit approval time

	Major	Minor	Not Imp.	DK/Ref
Regulators	38.10	49.52	12.38	0.00
Users	59.09	27.27	11.82	1.82
Vendors	40.00	40.80	11.20	8.00

Max 95% c.i.: Users = $\pm 6.47\%$; Vendors = $\pm 8.47\%$

7. Can you think of any other ways that the regulatory system hinders the consideration of **innovative** environmental technologies?

	Yes	No	No/DK/Ref
Regulators	28.57	71.43	0.00
Users	30.45	67.27	2.27
Vendors	33.60	64.80	1.60

Max 95% c.i.: Users = $\pm 6.17\%$; Vendors = $\pm 8.23\%$

IF YES, ASK: A. What are they?

First suggestion:

	fear of penalty	not eval quickly	lack of consist.	Regltrs uncoop.	Reg/proc not clr	prob w/spec reg	lack of enfrcmnt	regltrs lack	other data
Regulators	16.67	16.67	16.67	0.00	0.00	20.00	0.00	20.00	10.00
Users	11.94	10.45	10.45	17.91	13.43	4.48	1.49	10.45	19.40
Vendors	11.90	4.76	11.90	30.95	4.76	4.76	9.52	11.90	9.52

Second suggestion:

	not eval quickly	lack of consist.	regltrs uncoop	reg/proc not clr	prob w/spec reg	lack of enforcement	regltrs lack dat
Regulators	66.67	0.00	0.00	33.33	0.00	0.00	0.00
Users	14.29	14.29	14.29	0.00	42.86	0.00	14.29
Vendors	20.00	40.00	0.00	0.00	0.00	20.00	20.00

8. How would you rate the following components of the regulatory system as sources of barriers to innovative environmental technologies? Would you say that (READ ITEM) are a major barrier for your industry, a minor barrier, or not a barrier at all [to your industry]?

State Statutes

	Major	Minor	Not Imp.	DK/Ref
Regulators	5.71	55.24	39.05	0.00
Users	27.73	54.09	15.45	2.73
Vendors	17.60	51.20	23.20	8.00

Max 95% c.i.: Users = $\pm 6.57\%$; Vendors = $\pm 8.60\%$

State Regulations

	Major	Minor	Not Imp.	DK/Ref
Regulators	12.38	55.24	31.43	0.95
Users	31.36	52.27	14.09	2.27
Vendors	28.00	52.80	12.80	6.40

Max 95% c.i.: Users = $\pm 6.59\%$; Vendors = $\pm 8.60\%$

State Permits

	Major	Minor	Not Imp.	DK/Ref
Regulators	9.52	49.52	40.95	0.00
Users	39.55	45.45	11.82	3.18
Vendors	32.00	47.20	14.40	6.40

Max 95% c.i.: Users = $\pm 6.57\%$; Vendors = $\pm 8.60\%$

Federal Statutes

	Major	Minor	Not Imp.	DK/Ref
Regulators	28.57	48.57	19.05	3.81
Users	33.18	49.09	12.73	5.00
Vendors	34.40	42.40	16.80	6.40

Max 95% c.i.: Users = $\pm 6.59\%$; Vendors = $\pm 8.51\%$

Federal Regulations

	Major	Minor	Not Imp.	DK/Ref
Regulators	37.14	44.76	15.24	2.86
Users	40.91	43.64	12.27	3.18
Vendors	39.20	41.60	14.40	4.80

Max 95% c.i.: Users = $\pm 6.53\%$; Vendors = $\pm 8.49\%$

Federal Permits

	Major	Minor	Not Imp.	DK/Ref
Regulators	12.38	43.81	31.43	12.38
Users	30.91	41.82	21.36	5.91
Vendors	30.40	39.20	16.80	13.60

Max 95% c.i.: Users = $\pm 6.51\%$; Vendors = $\pm 8.41\%$

9. Now we would like you to consider separately the systems that regulate the various media such as air, water and solid or hazardous waste. Would you say that regulatory systems for (READ ITEM) are very likely, somewhat likely, or not at all likely to impose a barrier to using **innovative** technology.

Air

	not likely	somewhat likely	very likely	DK/NA
Regulators	25.71	28.57	13.33	32.38
Users	18.64	45.00	30.91	5.45
Vendors	20.00	38.40	15.20	26.40

Max 95% c.i.: Users = $\pm 6.55\%$; Vendors = $\pm 8.37\%$

Water

	not likely	somewhat likely	very likely	DK/NA
Regulators	23.81	41.90	2.86	31.43
Users	28.64	47.73	13.64	10.00
Vendors	14.40	40.00	18.40	27.20

Max 95% c.i.: Users = $\pm 6.59\%$; Vendors = $\pm 8.45\%$

Solid or hazardous waste

	not likely	somewhat likely	very likely	DK/NA
Regulators	7.62	40.95	15.24	36.19
Users	20.91	33.64	38.18	7.24
Vendors	12.00	22.40	18.40	47.20

Max 95% c.i.: Users = $\pm 6.41\%$; Vendors = $\pm 8.60\%$

10. In the past five years, how often do you think that industrial facilities/companies in your industry/industrial facilities have decided not to pursue a promising **innovative** technology or process because of the uncertainty of its complying with the environmental regulations or permitting?

	very often	some-time	not very often	never	DK/Ref
Regulators	8.57	42.86	29.52	6.67	12.38
Users	24.55	41.82	20.91	5.91	6.82
Vendors	40.80	42.40	10.40	2.40	4.00

Max 95% c.i.: Users = $\pm 6.51\%$; Vendors = $\pm 8.51\%$

11. Do you have any suggestions as to how the permitting and regulatory process can be changed to further promote the use of **innovative** environmental technologies?

	Yes	No	DK/Ref
Regulators	58.10	40.95	0.95
Users	60.00	35.91	4.09
Vendors	60.80	36.80	2.40

Max 95% c.i.: Users = $\pm 6.45\%$; Vendors = $\pm 8.41\%$

IF YES, ASK: A. What do you suggest?

First Suggestion

	knwldgbl regltrs	move gov funding	more incentives	better communic ation	more flexible	simplify reg/per	overall perf std
Regulators	6.56	4.92	13.11	9.84	26.23	6.56	6.56
Users	13.64	0.76	5.30	22.73	16.67	9.09	5.30
Vendors	11.84	7.89	17.11	10.53	5.26	9.21	9.21

	special treatment	reduce delays	multimed permits	bubbles or caps	consist enforce	gov tech verfctn	other
Regulators	4.92	0.00	3.28	0.00	0.00	1.64	16.39
Users	3.79	6.82	1.52	0.76	0.76	5.30	7.58
Vendors	3.95	6.58	0.00	0.00	0.00	11.84	6.58

Second Suggestion

	knwldgbl regltrs	move gov funding	more incentives	better communic ation	more flexible	simplify reg/per	overall perf std
Regulators	11.76	0.00	0.00	5.88	17.65	17.65	5.88
Users	14.81	7.41	11.11	25.93	14.81	0.00	3.70
Vendors	0.00	0.00	16.67	0.00	25.00	0.00	16.67

	special treatment	reduce delays	multimed permits	bubbles or caps	gov tech verfctn	other
Regulators	5.88	11.76	5.88	0.00	17.65	0.00
Users	3.70	0.00	3.70	0.00	7.41	7.41
Vendors	8.33	25.00	0.00	8.33	0.00	0.00

12. Do you think that the following changes would be very helpful, somewhat helpful, or not at all helpful in promoting the use of **innovative** environmental technologies?

Changing from technology-based to overall performance standards

	very	somewhat	not at all	DK/Ref
Regulators	34.29	48.57	12.38	4.76
Users	45.91	41.36	6.82	5.91
Vendors	49.60	36.00	8.00	6.40

Max 95% c.i.: Users = $\pm 6.57\%$; Vendors = $\pm 8.60\%$

Instituting special treatment in permitting or enforcement for innovative technologies

	very	somewhat	not at all	DK/Ref
Regulators	30.48	48.57	17.14	3.81
Users	46.82	40.91	9.09	3.18
Vendors	46.40	36.00	14.40	3.20

Max 95% c.i.: Users = $\pm 6.57\%$; Vendors = $\pm 8.58\%$

Reducing delays in the permitting system

	very	somewhat	not at all	DK/Ref
Regulators	29.52	33.33	33.33	3.81
Users	69.55	20.91	7.73	1.82
Vendors	53.60	34.40	8.00	4.00

Max 95% c.i.: Users = $\pm 6.06\%$; Vendors = $\pm 8.58\%$

Allowing multimedia permitting

	very	somewhat	not at all	DK/Ref
Regulators	21.90	30.48	41.90	5.71
Users	41.36	34.55	14.55	9.55
Vendors	31.20	36.00	15.20	17.60

Max 95% c.i.: Users = $\pm 6.49\%$; Vendors = $\pm 8.27\%$

Instituting bubbles or caps for multiple emission sources

	very	somewhat	not at all	DK/Ref
Regulators	27.62	39.05	12.38	20.95
Users	40.00	36.82	11.82	11.36
Vendors	19.20	36.00	11.20	33.60

Max 95% c.i.: Users = $\pm 6.45\%$; Vendors = $\pm 8.27\%$

Applying more consistent enforcement

	very	somewhat	not at all	DK/Ref
Regulators	35.24	31.43	30.48	2.86
Users	33.64	43.64	19.09	3.64
Vendors	61.60	28.00	7.20	3.20

Max 95% c.i.: Users = $\pm 6.53\%$; Vendors = $\pm 8.37\%$

Implementing government sponsored technology verification and demonstration

	very	somewhat	not at all	DK/Ref
Regulators	49.52	40.95	6.67	2.86
Users	41.36	36.82	17.73	4.09
Vendors	44.00	34.40	18.40	3.20

Max 95% c.i.: Users = $\pm 6.49\%$; Vendors = $\pm 8.55\%$

13. Now, thinking about industrial facilities/your own facility/industrial facilities, if there were no regulatory or permitting barriers to implementing **innovative** environmental technologies, what percentage of their/your/ their current compliance costs do you think could be saved?

	None	10% or less	10-23%	24-30%	33% or more
Regulators	9.52	23.81	19.05	33.33	14.29
Users	10.24	17.47	18.07	28.92	25.30
Vendors	3.90	12.99	27.27	27.27	28.57

Financial and Internal Barriers

14. We'd like to ask about specific barriers to technology innovation that are **not** related to the regulatory system. I'll read a list of these barriers. Drawing on your experience over the last five years, could you please rate each the following a major barrier, a minor barrier or not a barrier at all for technology users/your industry/technology users?

Lack of information on the availability of innovative technologies

	Major	Minor	Not Imp.	DK/Ref
Regulators	61.90	35.24	1.90	0.95
Users	33.18	50.91	15.45	0.45
Vendors	48.80	40.80	10.40	0.00

Max 95% c.i.: Users = $\pm 6.59\%$; Vendors = $\pm 8.60\%$

Lack of credible data on a technology's cost or performance

	Major	Minor	Not Imp.	DK/Ref
Regulators	75.24	23.81	0.95	0.00
Users	50.45	39.09	9.09	1.36
Vendors	61.60	31.20	7.20	0.00

Max 95% c.i.: Users = $\pm 6.59\%$; Vendors = $\pm 8.37\%$

Company staff not having time to make an assessment of technical options

	Major	Minor	Not Imp.	DK/Ref
Regulators	43.81	45.71	5.71	4.76
Users	55.45	37.27	7.27	0.00
Vendors	54.40	33.60	11.20	0.80

Max 95% c.i.: Users = $\pm 6.55\%$; Vendors = $\pm 8.58\%$

Company staff preferring end-of-pipe solutions to environmental requirements

	Major	Minor	Not Imp.	DK/Ref
Regulators	35.24	43.81	14.29	6.67
Users	20.00	54.55	22.73	2.73
Vendors	32.00	48.80	13.60	5.60

Max 95% c.i.: Users = $\pm 6.57\%$; Vendors = $\pm 8.60\%$

Financing for innovative technologies not being available

	Major	Minor	Not Imp.	DK/Ref
Regulators	54.29	31.43	4.76	9.52
Users	53.64	31.36	13.18	1.82
Vendors	60.80	29.60	8.80	0.80

Max 95% c.i.: Users = $\pm 6.57\%$; Vendors = $\pm 8.41\%$

Lack of financial benefits or rewards for using an innovative technology

	Major	Minor	Not Imp.	DK/Ref
Regulators	46.67	35.24	13.33	4.76
Users	51.36	31.36	16.82	0.45
Vendors	64.80	26.40	8.80	0.00

Max 95% c.i.: Users = $\pm 6.59\%$; Vendors = $\pm 8.23\%$

Large investments in technologies in place prevent the selection of new technologies

	Major	Minor	Not Imp.	DK/Ref
Regulators	56.19	32.38	7.62	3.81
Users	41.36	43.64	12.27	2.73
Vendors	42.40	50.40	5.60	1.60

Max 95% c.i.: Users = $\pm 6.53\%$; Vendors = $\pm 8.60\%$

15. Can you think of any other financial barriers or barriers internal to firms that have hindered the consideration of **innovative** technologies?

	Yes	No
Regulators	22.86	77.14
Users	9.09	90.91
Vendors	33.60	66.40

Max 95% c.i.: Users = $\pm 3.78\%$; Vendors = $\pm 8.13\%$

IF YES, ASK: A. What are they?

First Suggestion

	fear of fine/ rsk	reg/ perm system	refinance system	taxes	costs to replace	consults prefer	lack of money	bidding system	other
Regulators	25.00	12.50	4.17	8.33	25.00	8.33	16.67	0.00	0.00
Users	15.00	25.00	15.00	0.00	30.00	0.00	0.00	0.00	15.00
Vendors	19.05	9.52	9.52	7.14	4.76	2.38	35.71	4.76	7.14

Second Suggestion

	fear of find/rsk	reg/perm system	costs to replace	consults prefer
Regulators	00.00	50.00	0.00	50.00
Users	50.00	0.00	50.00	0.00
Vendors	50.00	0.00	25.00	25.00

16. Regarding financing, how difficult do you feel it is for firms to obtain financing for **innovative environmental technology** compared to **standard environmental technologies**? Is it...

	more	same	easier	DK/Ref
Regulators	56.19	18.10	0.95	24.76
Users	41.82	36.36	3.18	18.64
Vendors	47.20	41.60	2.40	8.80

Max 95% c.i.: Users = $\pm 6.51\%$; Vendors = $\pm 8.60\%$

17. I have asked about a variety of barriers to using innovative environmental technology. Are you aware of any other barriers that I did not mention?

	Yes	No
Regulators	11.43	88.57
Users	4.55	95.45
Vendors	3.20	96.80

Max 95% c.i.: Users = $\pm 2.74\%$; Vendors = $\pm 3.04\%$

IF YES ASK: What are they?

	public oppos.	Cultural barrier	bidding system	other
Regulators	58.33	16.67	0.00	25.00
Users	40.00	10.00	0.00	50.00
Vendors	25.00	50.00	25.00	0.00

18. Which of the following do you feel are significant benefits of using **innovative** environmental technologies? Is (READ ITEM) a significant benefit?

Lowered compliance costs

	Yes	No	DK/Ref
Regulators	78.10	13.33	8.57
Users	84.55	9.09	6.36
Vendors	81.60	9.60	8.80

Max 95% c.i.: Users = $\pm 4.76\%$; Vendors = $\pm 6.68\%$

Reduced pollution releases

	Yes	No	DK/Ref
Regulators	82.86	10.48	6.67
Users	91.36	4.55	4.09
Vendors	84.80	11.20	4.00

Max 95% c.i.: Users = $\pm 3.70\%$; Vendors = $\pm 6.19\%$

Fewer problems complying with environmental permits

	Yes	No	DK/Ref
Regulators	70.48	19.05	10.48
Users	74.55	16.82	8.64
Vendors	61.60	28.00	10.40

Max 95% c.i.: Users = $\pm 5.74\%$; Vendors = $\pm 8.37\%$

Improved production efficiency

	Yes	No	DK/Ref
Regulators	82.86	4.76	12.38
Users	79.55	13.64	6.92
Vendors	77.60	18.40	4.00

Max 95% c.i.: Users = $\pm 5.31\%$; Vendors = $\pm 7.17\%$

Liability (vendors only)

The next few questions deal with the issue of your firm's liability for injury to private parties for putting people at risk specifically due to the failure of an environmental technology that your firm might develop in the future.

18. Have concerns about such liability discouraged you from developing, selling, or licensing an **innovative** environmental technology, in favor of an older more established approach?

	Yes	No	DK/Ref
Vendors	26.40	67.20	6.40

Max 95% c.i. = $\pm 8.09\%$

19. Would you rate the following concerns about liability as major, minor or not applicable?

The fear of being sued by technology users, customers, or citizens if a technology fails

	Major	Minor	Not Imp.	DK/Ref
Vendors	39.20	42.40	14.40	4.00

Max 95% c.i. = $\pm 8.51\%$

The cost of product liability insurance or the inability to get insurance

	Major	Minor	Not Imp.	DK/Ref
Vendors	34.40	46.40	14.40	4.80

Max 95% c.i. = ± 8.58

The time demands on company personnel in dealing with liability issues

	Major	Minor	Not Imp.	DK/Ref
Vendors	24.00	56.80	15.20	4.00

Max 95% c.i. = $\pm 8.53\%$

Difficulty in developing technologies jointly through partnerships

	Major	Minor	Not Imp.	DK/Ref
Vendors	19.20	53.60	20.00	7.20

Max 95% c.i. = $\pm 8.58\%$

Information (regulators and users only)

19. We'd like to know where you go for information or technical assistance about alternative practices or technologies to address environmental issues. Specifically, we'd like to know if you found the following resources very useful, somewhat useful, or not at all useful as a source of information.

Other companies

	very	somewhat	not at all	DK/Ref
Regulators	33.33	48.57	16.19	1.90
Users	38.64	47.27	14.09	0.00

Max 95% c.i.: Users = ± 6.59%

Your facility's employees or own research

	very	somewhat	not at all	DK/Ref
Regulators	42.86	43.81	8.57	4.76
Users	38.18	45.00	16.82	0.00

Max 95% c.i.: Users = ± 6.55%

Government technical assistance office, university or extension programs

	very	somewhat	not at all	DK/Ref
Regulators	58.10	35.24	4.76	1.90
Users	23.64	48.18	25.00	3.18

Max 95% c.i.: Users = ± 6.59%

Small business assistance program

	very	somewhat	not at all	DK/Ref
Regulators	10.48	37.14	43.81	8.57
Users	5.91	15.91	70.00	8.18

Max 95% c.i.: Users = $\pm 6.04\%$

Industry trade associations, publications or conferences

	very	somewhat	not at all	DK/Ref
Regulators	52.38	41.90	3.81	1.90
Users	62.73	32.27	5.00	0.00

Max 95% c.i.: Users = $\pm 6.37\%$

Outside consultants or contractors

	very	somewhat	not at all	DK/Ref
Regulators	23.81	60.95	11.43	3.81
Users	48.18	45.00	6.82	0.00

Max 95% c.i.: Users = $\pm 6.59\%$

Vendors and suppliers

	very	somewhat	not at all	DK/Ref
Regulators	26.67	57.14	15.24	0.95
Users	34.09	58.64	7.27	0.00

Max 95% c.i.: Users = $\pm 6.49\%$

Customers

	very	somewhat	not at all	DK/Ref
Regulators	24.76	44.76	22.86	7.62
Users	9.09	30.45	57.73	2.73

Max 95% c.i.: Users = $\pm 6.51\%$

Any other resources?

First Suggestion

	none	Internet	regltrs /regultns	other
Regulators	00.00	72.73	27.27	0.00
Users	7.69	73.08	3.85	15.38

20. Do the environmental technologies that your firm uses come from **(users only)**:

Your company's own research and development

	Yes	No
Users	54.54	45.45

Max 95% c.i.= $\pm 6.57\%$

Contractors to your company

	Yes	No
Users	63.64	36.36

Max 95% c.i.= $\pm 6.33\%$

Independent technology vendors

	Yes	No
Users	66.82	33.18

Max 95% c.i.= ± 6.21%

Other?

	Yes	No
Users	10.90	89.09

Max 95% c.i.= ± 4.12%

	consultants	trade assoc	other
Users	50.00	16.67	33.33

Background/Details

Finally, I have a few questions for background purposes.

22. About how many full-time employees work at this facility (**users and vendors only**)?

	1-41	42-125	130-380	400-10K
Users	16.97	18.35	27.98	36.70
Vendors	36.00	37.60	19.20	7.20

23. Does your facility have a parent company (**users and vendors only**)?

	Yes	No	DK/Ref
Users	68.18	31.36	0.45
Vendors	54.40	45.60	0.00

Max 95% c.i.: Users = $\pm 6.13\%$; Vendors = $\pm 8.58\%$

24. How many employees work in the whole company (**users and vendors only**)?

	Q1:1-450	Q2:500-3000	Q3:3,500-12,000	Q4:14,000-80,000
Users	15.08	26.98	24.60	33.33
Vendors	41.27	22.22	26.98	9.52

25. Could you give me an estimate of this facility's annual environmental compliance costs (**users only**)?

	<,\$75k/yr	\$80-350K/yr	\$400k-1.8MM/yr	>,\$2MM/yr
Users	24.00	23.33	28.00	24.67

26. In terms of competitiveness and financial strength, do you feel that your company is stronger, about the same, or less strong than it was three years ago (**vendors and users only**)?

	stronger	same	less strong	DK/Ref
Users	66.36	21.36	10.00	2.27
Vendors	67.20	19.20	12.80	0.80

Max 95% c.i.: Users = $\pm 6.23\%$; Vendors = $\pm 8.09\%$

27. In terms of workload, do you feel that your office is more burdened, about the same, or less burdened than it was two years ago **(regulators only)**?

	more burdened	same	less burdened	DK/Ref
Regulators	74.29	17.14	5.71	2.86

28. Has the percent your company spent on research and development increased, stayed the same, or decreased, over the past three years **(vendors only)**?

	increase	same	decrease	No R&D	DK/Ref
Vendors	48.80	29.60	16.80	2.40	2.40

29. Does your company's research and development **mostly** come from **(vendors only)** your own company's staff, universities, collaboration with other companies, parent company, government research efforts, or some other source?

	company staff	univs	other cos.	parent company	govern-ment resrch	other	DK/Ref
Vendors	71.90	3.31	11.57	4.13	3.31	4.96	0.83

30. How many years have you worked in permitting/environmental compliance/your field?

	<=5 yrs	6-10 yrs	11-19 yrs	20 or more
Regulators	13.33	25.71	30.48	30.48
Users	29.09	32.27	20.00	18.64
Vendors	14.40	24.80	27.20	33.60

Those are all the questions that I have. Thank you very much for your time.